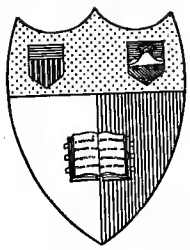

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COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

PUBLICATION NUMBER NINE OF THE
ERNEST KEMPTON ADAMS FUND FOR PHYSICAL RESEARCH

ESTABLISHED DECEMBER 17TH, 1904

PARALLAXES OF 260 STARS

DERIVED FROM PHOTOGRAPHS MADE AT THE LEANDER McCORMICK OBSERVATORY

BY

S. A. MITCHELL, PH.D.

PROFESSOR OF ASTRONOMY IN THE UNIVERSITY OF VIRGINIA AND DIRECTOR OF THE McCORMICK OBSERVATORY, ADAMS RESEARCH FELLOW OF COLUMBIA UNIVERSITY, 1913–15; SPECIAL ADAMS RESEARCH FELLOW, 1915–

ASSISTED BY

C. P. OLIVIER, H. L. ALDEN AND OTHERS

NEW YORK
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1920

The Leander McCormick Observatory, University of Virginia.

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ON the seventeenth day of December, nineteen hundred and four, Edward Dean Adams, of New York, established in Columbia University "The Ernest Kempton Adams Fund for Physical Research" as a memorial to his son, Ernest Kempton Adams, who received the degrees of Electrical Engineering in 1897 and Master of Arts in 1898, and who devoted his life to scientific research. The income of this fund is, by the terms of the deed of gift, to be devoted to the maintenance of a research fellowship and to the publication and distribution of the results of scientific research on the part of the fellow.

(For list of Adams Fund Publications see back cover page)

CONTENTS

	PAGE
The Leander McCormick Observatory	1
Parallax Methods	3
The Meridian Circle	7
The Heliometer	8
Early Photographic Work	10
Later Photographic Work	13
Photographic Apparatus	18
Photographic Methods	19
Elimination of Errors of the Photographs	22
Guiding Error	24
Choice of Comparison Stars	28
Methods of Measurement	29
Reductions of the Plates	32
Elimination of Systematic Errors	34
Proper Motions	36
Spectroscopic Parallaxes	38
The Detailed Results	39
Average Probable Errors	643
Comparisons with the Early Parallaxes	643
Comparisons with the Yale Heliometer	646
Comparisons with Modern Photographic Parallaxes	647
The Ursa Major Group	649
Mean Parallaxes related to Proper Motions and Magnitudes	651
Mean Parallaxes Computed from McCormick Relative Parallaxes	652
Constants for Mean Paral axes of F, G, K and M Stars	654
Comparisons with Mean Parallaxes from Van Rhijn's Tables	655
Fifteen Exceptional Stars	657
Comparisons with Spectroscopic Parallaxes	657
Masses	659
Mass-Ratios	660
Summary	662
Table of Parallaxes and Proper Motions	665

PART II.

Measures of Double Stars on Parallax Plates	679

PARALLAXES OF 260 STARS

DERIVED FROM PHOTOGRAPHS MADE AT THE LEANDER McCORMICK OBSERVATORY

BY

S. A. MITCHELL

ASSISTED BY

C. P. OLIVIER, H. L. ALDEN, AND OTHERS

THE Leander McCormick Observatory owes its existence to the generosity of the late Leander J. McCormick of Chicago. Born in Rockbridge County, Virginia, and desiring to do something to prove his affection for his native state, he contracted with Alvan Clark and Sons for a mate of the telescope they were then making for the U. S. Naval Observatory, and he offered, on specified conditions, to present it to Washington and Lee University, at Lexington, in the county where he was born. As those conditions were not met, he next offered it to the University of Virginia, through Col. Venable, the professor of mathematics in the latter institution, who immediately took steps toward raising the necessary endowments. In answer to an appeal to the state legislature, that body passed resolutions recognizing the generosity of the donor and the importance of securing such a telescope, but did not deem it wise in the condition of the state finances at that time (1878), to make the appropriation. An appeal was then made to the alumni of the university, and a fund of over $50,000 was raised to pay the salary of the director. To this sum, Mr. William H. Vanderbilt of New York, added $25,000 as the beginning of a working fund. The university provided ample grounds and built the director's

residence on the summit of Mt. Jefferson. It may be interesting to note that this was the actual site chosen for an observatory by the founder of the university, Thomas Jefferson, and a small observatory in reality had been built there. Mr. McCormick gave the telescope, the mounting, and the observatory building. This building is not very large, consisting merely of a dome, forty-five feet in diameter, constructed by Warner and Swazey, to which are attached two rooms which serve as offices.

The telescope was mounted and work with it was begun in 1883, with the observatory under the directorship of Professor Ormond Stone. The McCormick telescope is not an exact duplicate of the U. S. Naval Observatory instrument. It has an aperture slightly larger than the Washington telescope. As a matter of fact, it was constructed with an aperture of 26¼ inches so that it might be the largest of any refractor in the United States, a proud position which it held for only a short time.

In planning the work to be undertaken at the new observatory, Professor Stone took advantage of the great light-gathering power of the lens to make a photometric study of the nebula of Orion, and to make a survey of the heavens to discover new and faint nebulae, mainly in the southern skies. An account of these researches is found in the *Publications of the Leander McCormick Observatory*, volume 1. During the period from 1890 to 1902, many micrometrical measures on the satellites of the planets were made, as well as observations of many of the comets appearing during that interval. From 1894 to 1902 Professor Stone and several of the assistants made extended series of measures of the fainter satellites of Saturn. The McCormick Observatory also took a full part in the Eros campaign of 1900. The telescope was also used for the measurement of doubles, this work being done mainly by F. P. Leavenworth, C. P. Olivier, and R. E. Wilson. These measures are found in the *Publications*, and also in the *Astronomical Journal* and *Astronomische Nachrichten*. In 1901, in coöperation with Harvard, Lick and Yerkes Observatories, work was begun with the wedge photometer. The measures were carried out mainly by H. D. Curtis, T. McN. Simpson and F. W. Reed. Following this, in 1903, variable star observations were

taken up, visual estimates being made by the Argelander method. No account of these photometric measures nor of the variable star work has yet been published. Professor Stone resigned as director of the observatory in 1912. Under his care, the investigations carried out had been entirely visual, no photographic work of any sort having been attempted with the refractor.

In September, 1913, S. A. Mitchell assumed the duties of director. It seemed wise that photographic work with the refractor should be started, and accordingly a photographic dark-room was constructed, and arrangements were made with the university for the installation of electric lights and running water. But what photographic work should be attempted? The choice seemed to lie between the determination of radial velocities by the spectrograph and the investigation of stellar parallax. So much excellent work has been accomplished in the measurements of the motions of stars in the line of sight, first by powerful refractors and then later by still more powerful reflectors, that it did indeed seem that another large refractor devoted to this line of work could add comparatively little in constructive research.

In investigations of stellar distances the situation in 1913 was very different. In the Silliman* lectures delivered at Yale University in 1910, the director of the Lick Observatory spoke as follows: "Measures of stellar distances present difficulties so great that even today we possess reliable knowledge of the approximate distances of not over a hundred stars. At no point in astronomical science is fuller knowledge more desirable, more pressingly urgent, than in the subject of stellar distances; or speaking technically, of stellar parallaxes."

Schlesinger had recently published in the *Astrophysical Journal* for 1910 and 1911 a remarkable series of papers in which were given the methods and the measurements of the distances of 28 stars determined by photography with the 40-inch refractor of the Yerkes Observatory.

The photographic measures given by Schlesinger showed a vast increase in accuracy over the older methods of determining parallaxes visually, whether obtained by heliometer, by meridian

* "Stellar Motions," W. W. Campbell, Yale University Press, 1913.

circle or by micrometer. The work so admirably done by Schlesinger was continued at Yerkes by Slocum and Mitchell who published the parallaxes of 61 stars which showed an accuracy as indicated by a probable error of $\pm$ 0".009. In addition to the Yerkes refractor, there were but three other telescopes which had followed the example of Yerkes and were engaging in determining stellar distances by photography, and these were the 60-inch reflector at Mt. Wilson, the 26-inch refractor at Greenwich, and the 24-inch refractor at Swarthmore. With only four telescopes devoted to the determination of stellar distances by photography, it seemed advisable that the 26-inch McCormick refractor should also attempt this work, and that the main energies of the observatory staff should be devoted to carrying out these researches.

Since the present publication is not written for astronomers only, it might not be out of place to recount briefly the history of the determination of the distances of the stars. (For a fuller account see Sir F. W. Dyson, "Measurement of the Distances of the Stars," *Observatory*, 249, 292, 1915.) The finding of the distances of the stars is a problem somewhat similar to that which faces the surveyor in his attempt to measure the distance across a river which it is impossible to cross. This latter problem is readily accomplished by carefully measuring the length of a base-line on the surveyor's side of the river, and then measuring the angles from each end of this line to some prominent point, as a church spire or a tree, on the other side of the river. The distance is found by elementary trigonometry. If the tree across the river chosen by the surveyor for his measurements had been a near-by tree located on the edge of a woods, then if he walked from one end of his base-line to the other and had kept his eyes on this tree, the surveyor would have seen it change its position relative to the background of trees behind. If the tree were fairly close to the surveyor, this angular displacement would be comparatively large, while the farther and farther distant the tree is from the surveyor, the smaller and smaller would the displacement become.

In quite a similar way, the distances to the stars are found. Once a year the earth travels about the sun in an orbit which is

approximately a circle, and where the distance from sun to earth is ninety-three millions of miles. Consequently, after a lapse of six months, the earth finds itself at a position one hundred and eighty-six millions of miles from where it had been earlier. Do not the stars nearest to the earth and sun suffer a displacement relative to the far-off stars, just as the near tree is displaced as the surveyor walks the length of his base-line? This question was asked of the followers of the Copernican system, and as no such displacement was actually observed, the conclusions were obvious,—either that the Copernican system was false and the earth did not circle about the sun, or else the stellar displacements were smaller than could be observed by the naked eye. The displacements were too small even to be discovered by the telescope invented by Galileo in 1609, and so one was forced to assume that the universe was made on a much larger scale than had once been thought.

With each increase in telescopic power, with each improvement in measurement which added to the accuracy of stellar measurements, the problem of finding the distance of the stars was again attacked. Hooke, Flamsteed, Picard, Cassini, Horrebow, and Halley each in turn attempted to find a displacement of the stars, but each in turn failed, though Halley found that three of the brightest stars, Aldebaran, Sirius and Arcturus, were not in reality *fixed*, since each star had a slight, but unmistakable motion of its own. Halley came to the conclusion that the stars were at least 20,000 or 30,000 times more distant than the sun, though the exact distance of the sun was then unknown.

In attempting to measure the distance of the stars, the astronomer Bradley discovered the aberration of light, and also nutation, and he recognized that one star γ Draconis must be more than 200,000 times farther from the Earth than is the Sun.

Assuming that bright stars on the average must be closer to us than faint stars, Sir William Herschel attempted an ingenious method of detecting the displacement of the stars caused by the earth's annual journey about the sun by measuring accurately the relative positions of stars near each other in the sky, one being bright, the other faint. Although Herschel did not succeed

in detecting the parallaxes of any stars, he did find an entirely new class of stars, of which we now know many thousand, namely, double or binary stars.

Following Herschel's time, many attempts were made to measure the distances to the stars, but these attempts ended only in failure. It remained for the year 1838 to have the honor of recording the first stellar distance, and singularly enough, the distance of not only one star was measured but three, by three different observers, using instruments of three different types and employing three different methods. The greatest honor probably belongs to Bessel in determining the distance of 61 Cygni, though Henderson found the distance of α Centauri, and Struve gave that of α Lyrae. Each of the three sought to measure the displacement of the star with respect to fainter stars, but the method of measurement used by Bessel was the best and led to the most accurate results.

The instrument used by Bessel was called the heliometer. Its object-glass had the peculiarity that it was cut exactly in halves. Since each half-objective forms a complete image of every star in the field of view towards which the heliometer is pointed, it is readily possible to measure the angular distance of one star from the other by displacing the two halves of the objective by a known and measurable amount; and by rotating the objective on the end of the tube to determine the position of the two stars relative to each other.

The method employed by Struve to measure the displacement of α Lyræ with respect to the neighboring stars was by using the filar micrometer on the eye-end of the equatorial telescope. This is the attachment usually employed in the measurement of the position angle and distance of the components of a double star. Where the angular distances are small, the micrometer in skillful hands gives a wonderful degree of precision. In the process of measurement, it is necessary to put the fixed wire of the micrometer on one component of the double, and the movable wire on the other component. The accuracy of the measurement depends on the skill with which the observer can bisect *both* stars of the double at the same time. The difficulty in accomplishing this is great since most observers must first look

at one star to see whether the bisection is perfect and then to the other star, and the difficulty becomes the greater as the angular distance between the stars is increased. With the heliometer, however, the measurement of a large angular distance can be secured with as great a precision and with as great ease as when the distance is small. The result has been that measures with the equatorial telescope and micrometer have given stellar parallaxes which may be very greatly in error. The main difficulty lies in the fact that usually the only stars that are available as comparison stars for the measurement of the displacement of the parallax star are at such great angular distances that the micrometer cannot be employed with sufficiently adequate precision.

Henderson's instrument used for discovering the distance of the star α Centauri, which still holds the place of honor of being the nearest fixed star that we know, was the meridian circle. This instrument furnishes the right ascension and the declination of the stars in the sky, and gives therefore what is known as their absolute positions. Two different methods may be followed to determine the parallaxes of stars with the meridian circle. The first method is to find the absolute position of the star at times during the year when the earth is at opposite ends of its orbit, and to obtain from a comparision of these absolute positions the amount of change in position which is caused by the motion of the earth. This change in position may be either in right ascension, or in declination, or in both. The second method is in comparing the right ascension or declination of a star whose parallax is to be determined with the right ascension or declination of a near-by star or stars, which shall serve as comparison stars. The first procedure may be called the absolute method, the second the differential one.

For obvious reasons, which it is not necessary to discuss here, the differential method gives the more accurate results. But even the differential method may be subject to large systematic errors since the parallax star and the comparison stars usually are of quite different magnitudes. The average observer will measure quite differently the exact time at which a bright and a faint star will cross a wire, although gauze screens are

placed before the telescopic objective to be rid of this systematic effect. For a star on the equator one second of time is equal to fifteen seconds of arc. A precision measured by a probable error of $\pm$ 0".01 (one-hundredth of a second of arc) would require of an equatorial star a precision measured by one fifteen-hundredth of a second of time. If, therefore, one is to determine stellar parallaxes by the meridian circle by means of observations in right ascension, there will be required a remarkably perfect instrument and an observer wonderfully skillful and careful, if an accuracy is to be attained which is comparable with modern photographic work.

According to Dyson (*loc. cit.*), the heliometer of Bessel which was used to measure the distance of 61 Cygni with such accurate results was later employed by Schlüter and Wickmann in measuring the distance of Groombridge 1830, an interesting star with a proper motion, the largest then known. With the same instrument in the sixties, Auwers determined the parallax of several stars, while with the heliometer at Bonn, Krueger and Winnecke measured the distances of five stars. The third heliometer to be employed, though only four inches in aperture, in the capable hands of Gill, the director of the observatory at the Cape of Good Hope, and Elkin, afterwards director of Yale Observatory, gave the distances of nine stars in the Southern Hemisphere with a high degree of accuracy. After such a notable start, Gill and Elkin continued their measures separately. Gill and his assistants at the Cape with a seven-inch heliometer, determined the distances of no less than 17 stars between the years 1888 and 1898. On being appointed director of the Yale Observatory in 1884, Elkin with the assistance of Chase and Smith carried out a most remarkable series of measurements, which resulted in the determination of the distances of 238 stars. This work was published in 1912. Other observations with the heliometer were carried out at Leipzig with a six-inch instrument. Between the years 1890 and 1911, Peter determined the parallaxes of 20 stars.

As an example of the character of the work capable of being done by the heliometer, the results are given below of the excellent measures by Elkin with the Yale heliometer on the bright

star α Canis Minoris, as given in the *Transactions of the Yale Observatory*, **1**, 287.. The star was measured with respect to thirteen comparison stars in seven separate series, six of which had two comparison stars, and the seventh of which had only one. The parallax of α Canis Minoris as derived from each of the seven series follows:

Series	I	$\pi = +0''.257 \pm 0''.018$
	II	$.461 \pm .035$
	III	$.367 \pm .018$
	IV	$.366 \pm .023$
	V	$.503 \pm .049$
	VI	$.294 \pm .019$
	VII	$0.228 \pm 0''.020$
Mean		$\pi = 0''.334 \pm 0''.015$

Altogether 128 observations contributed to this result. The measures, though most carefully made show results which have a range in value from $+0''.228$ to $+0''.503$. Such a range in values coming from the hands of a skillful observer after many years of training shows the limitations of the heliometer.

Although the measures with the heliometer have given excellent results, the scope of astronomical work that may be accomplished by such an instrument is very limited, with the consequent result that very few heliometers have ever been constructed. The case is far different with the meridian circle, for there are in existence very many excellent instruments devoted to this department of astrometry. Kapteyn was the first to show that satisfactory parallaxes might be determined with the meridian circle, provided that sufficient care be taken with the method of observation. Instead of obtaining the absolute places of the stars, more satisfactory results could be obtained if the parallax star were referred to one or more comparison stars, and if the differential displacements were secured relative to these comparison stars. The results for parallax secured by Kapteyn possess a high degree of accuracy. Here then was a method that did not require a specially constructed and highly intricate instrument like the heliometer, but the many hundreds of meridian circles about the world could apparently give valuable results in the field of this very difficult

line of research, the determination of the distances of the stars. Accordingly, many astronomers devoted themselves to observations with meridian circles with the greatest of zeal. Chief among these indefatigable workers might be mentioned the names of Flint of the Washburn Observatory of the University of Wisconsin, Jost, Jewdokimov, Grossmann, G. Abetti, and Voûte.

In the securing of stellar parallaxes, the meridian circle has two advantages over the heliometer; first, that a special instrument is not needed for parallax work, results being obtained with existing apparatus, and, second, parallaxes can be determined with an expenditure of labor that is less in the case of the meridian circle than the heliometer. According to the estimation of Dyson, however (*loc. cit.*, p. 297), work with the meridian circle on as many as 50 nights gives parallaxes "which are not nearly as accurate as the best heliometer observations."

Of all the methods of obtaining parallaxes by visual methods, unquestionably the best results can be obtained with the heliometer. But even though the instrument be a most perfect one, the observer highly trained, skillful, and careful, parallaxes can be obtained by the heliometer only after a prodigious amount of labor, and even then, the results from careful work may disagree, as was plainly shown in the case of Elkin's work on the star α Canis Minoris (p. 9).

Early Photographic Work.

On account of the very large role that photography has played in the astronomy of precision, it is but natural that attempts should have been made to determine parallaxes by photographic processes. The first real attempt was the work of Pritchard at Oxford who took a large number of photographs between the years 1887 and 1889. Pritchard determined the parallaxes of 28 stars, and if one should judge only by the size of the probable errors derived, the parallaxes possessed a high degree of precision. But compared with later and more accurate work, Pritchard's results show considerable systematic errors.

Photographs even older than Pritchard's, those of Lewis Morris Rutherfurd taken in New York in the sixties and seventies,

have been discussed for the determination of stellar parallax. At Columbia University, Jacoby determined the parallaxes of β Cygni, of μ and θ Cassiopeiæ, Davis found those of 61 Cygni and η Cassiopeiæ, while Bauer redetermined the parallax of μ Cassiopeiæ. Judged by the criterion of the size of the probable error, the Columbia measures seemed also to show a considerable degree of precision, but compared with later results these parallaxes are evidently much in error. Nor is it difficult to find the reasons for the discordances of the early photographic parallaxes. The Columbia measures of the Rutherfurd photographs were very accurately carried out, as the results fully show, but the plates were taken with no special reference to parallax determination, often at very large hour angles, with the result that large systematic errors crept into the work and vitiated the value of the parallaxes determined.

The work of Kapteyn began a new era in the measurement of parallaxes by photography. In the *Publications of the Astronomical Laboratory at Groningen*, **1**, 1900, are given the parallaxes of 248 stars of the region around B. D. + 35°.4013 contained on photographs prepared by Prof. A. Donner. The method employed in taking the photographs was quite novel. This was described by Donner as follows: "On each plate one and the same region was to be photographed at *three* consecutive maxima of parallax. At the first maximum, *one* to *three* images were to be taken; in the case of more than one image, these were to lie at small distances on the same circle of declination. The images of the second maximum were to form two such rows, those of the third maximum a single one like those of the first. The first images of the four rows were to lie due east and west, similarly the second and also the third images." After exposing the plate to the first set of three images, the plate was put away without development until the time had arrived, six months later for the second and the third sets of images, when again the plate was put away undeveloped, and the development did not take place until the fourth set of exposures were made, approximately one year after the initial set. Each plate of three images exposed at four different times gave twelve images for each and every star on the plate. The measurements of all the plates

taken were carried out with the utmost care, and when the calculations were completed a thorough discussion was made of the results. Kapteyn's conclusions were that very accurate values of the parallax of large numbers of stars can thus be obtained with great rapidity, and that the results are free from systematic error, if certain reasonable precautions are taken. A knowledge of these "reasonable precautions" has been of the greatest help to all those who have since investigated parallaxes by photography. The precautions were:

1. In photographing, the telescope should be used on one side of the pier only.
2. Photographs should be taken when the star is as nearly on the meridian as possible.
3. The greatest care must be taken in guiding.
4. Each plate should be measured direct and again when reversed 180°.

Kapteyn's method was intended to give the parallax of each and every star on the photographs. When the results were collected and the parallax values of the various stars on the plates compared with one another, it was readily seen that small parallaxes occurred with much greater frequency than larger ones, and that positive and negative values were found in equal numbers, though the total numbers of positive values were slightly in excess. It therefore appeared as if the parallax values were distributed according to the law of errors, or in other words, the parallaxes were in most cases illusory.

The work of Kapteyn demonstrated very clearly that it was possible by photography to obtain parallaxes with an accuracy comparable with that attained by the heliometer, and with an expenditure of energy far less than with the heliometer.

The photographs discussed by Kapteyn were taken by Donner at Helsingfors with one of the so-called astrographic telescopes, where the focal length of a little over eleven feet insured that the scale on the photographic plate was one millimeter equal to one minute, or sixty seconds of arc. It was easy to see that telescopes of greater focal length would result in parallaxes of a higher degree of precision. Although there are many "astrographic telescopes" in existence, few of them have ever been utilized in measurements of parallax.

Henry Norris Russell gives an excellent description of methods of obtaining stellar distances by photography in the *Determinations of Stellar Parallax* from photographs taken at the Cambridge Observatory, England, by Russell and Hinks, published by the Carnegie Institution of Washington in 1911. The photographs were made in the years 1903 to 1907 with the Sheepshanks Equatorial of the Coudé form. The object glass of twelve-inch aperture had a focal length of 19.3 feet which resulted in photographs where the scale was 1 mm = 35″.2, approximately double the scale of the photographs employed by Kapteyn. In 37 regions in the sky Russell determines the parallax of 52 stars. The error in the determination of a star resulting from the measure of a single plate of good quality on which are impressed four separate images of the star was found by Russell to be 0″.048. From an interesting table, he finds that this is a higher degree of precision than had been attained by any observer using visual observations whether the instrument used is the heliometer, the equatorial, or the meridian circle. Not only is the accuracy by photography much higher than can be reached by visual methods, but the labor involved is much less in the case of photography.

Russell's work is an excellent contribution to the subject of stellar distances. Sir David Gill, himself a great authority on stellar parallaxes (*Monthly Notices R. A. S.*, **62**, 325, 1912) says, "The Cambridge results give results of an accuracy which, but for the wonderful precision of the Yerkes observations would have been regarded as the highest class."

Later Photographic Work.

The distances of the stars are enormous compared to the diameter of the earth's orbit—the only base-line available for the measurement of these distances—and in consequence, the parallactic shift is infinitesimally small. The guiding principle that must underlie all advances in this difficult subject may be found in the words of Gill (*M. N.* **62**, 325, 1912). "The most careful previous consideration of every imaginable source of systematic error, and the provision of means for its automatic elimination alone renders progress possible in that extreme

refinement of micrometric research which nowadays is necessary for the extension of our knowledge of stellar parallax. It is important to note that every preconceived source of possible error has turned out to be a reality, and it has in every case been found to be desirable to refine on the precautions for its elimination in a degree not at first contemplated."

It is hoped that the results in the present work will show that the refinements in the refinements of precautions have all been carefully looked after and that the parallaxes will be found to be free from all systematic errors.

One great advantage that Russell had in his work over that of the heliometer or meridian circle was the much greater focal length of the instrument used by him. It is quite conceivable that if one could use visually a heliometer of the great focal length (62 feet) of the 40-inch Yerkes refractor, it would then be possible to obtain parallaxes visually with as high a degree of precision as is found in the best photographic work. But there is not a heliometer of 62 feet focal length in existence, nor would it pay to construct one! There are many obvious advantages of photography over visual methods. One of the most striking is that by photography a record is obtained on a plate which may be examined at once, or may be put away to be examined later at one's leisure. Apparently, a great gain in accuracy in the determination of stellar distances would result if the largest astronomical telescopes could be utilized for this purpose in place of the shorter focal lengths of the heliometer and meridian circle. The refracting telescope of greatest focal length is the Yerkes lens of aperture 40 inches and focal length of 62 feet. This superb object glass is from the hands of Alvan Clark and Sons of Cambridge, Mass., and the mounting from the shops of Warner and Swazey of Cleveland, Ohio. This lens, however, is a visual one, and it was not manufactured by the Clarks to be used for photographic work.

Making use of an artifice used by the landscape photographer who obtained photographs exquisite in detail by the use of a color filter and isochromatic plates, Ritchey* was able to obtain astronomical photographs of great excellence. The principle

* *Astrophysical Journal*, **12**, 352, 1900.

underlying this is very easy to understand. The Clarks made the 40-inch objective so that two of the visual rays, those that most strongly affect the eye, the yellow and the green, should be brought to a sharp focus. The other rays of the spectrum, the blue and violet at one end of the spectrum and the red at the end of long wave-lengths are more or less out of focus. In a visual telescope the blue and violet out-of-focus light combines with the red light, also out of focus, to make a purple glow about the visual (yellow and green) stellar nucleus. The larger the telescope the more evident is the purple glow.

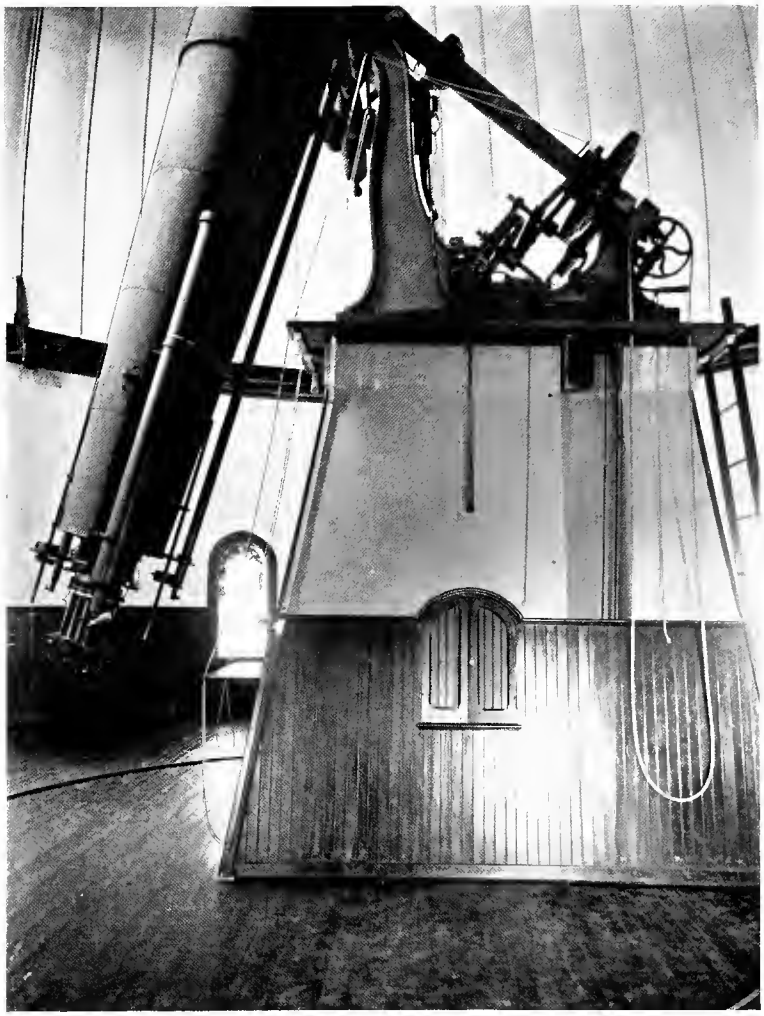
The ordinary photographic plate is most sensitive to the violet and blue light, and less and less sensitive as the end of the spectrum of longer wave-lengths is approached, being entirely insensitive to red light. A photograph taken with an ordinary plate at the visual focus of the 40-inch telescope would give star images which would be quite large on account of the out-of-focus light. If a plate of a different kind could be used which would be highly sensitive to the yellow and green, and little sensitive to the blue, violet, and red, then sharp star-images would result. But no such plate has ever been invented, though the Cramer Isochromatic plate approximates to it. This plate is highly sensitive in the yellow, very little sensitive to the red, but quite considerably sensitive to the blue and violet. If one should interpose a "color filter" in the path of the light in such a way that the light would be obliged to pass through the color filter before falling on the photographic plate, then the color filter would absorb some of the incident light. Color filters vary in their absorbing powers. One can be made which will absorb the violet, blue and blue-green, allowing only the green, yellow, and red rays to pass through it unobstructed. If such a filter were used in combination with a Cramer Isochromatic plate which is almost insensitive to red light, then a photograph would result in which only the green and yellow rays have any power to affect the plate, and those are exactly the rays for which the visual telescope is corrected by the optician. Since the Cramer plate is much more sensitive to the yellow than the green, the photographs with a telescope like the 40-inch, ground by the Clarks, are taken almost exclusively with the yellow light.

Consequently, Ritchey was able to obtain with the 40-inch visual lens photographs of excellent definition where the star-images are very small and clean-cut. Such photographs rendered possible a new epoch in exact stellar measurements. In the years 1903 to 1905, Schlesinger secured photographs, the measures of which are given in *Photographic Determination of Stellar Parallax made with the Yerkes Refractor*, and published in the *Astrophysical Journal* (vols. **32**, **33** and **34**) in the years 1910 and 1911. The parallaxes of 28 stars were determined with an accuracy considerably greater than that attained by the very best of the earlier work. Schlesinger gave a masterful discussion of the subject of parallaxes, and those who have followed him are deeply grateful to him for the magnificent service he rendered to exact astronomy, particularly in the invention of the methods of "dependences" used with such success in abbreviating the work of reduction of stellar photographs.

Schlesinger's work on stellar parallax at Yerkes was discontinued there when he was called to the Allegheny Observatory as its director.

The photographs made by Schlesinger were obtained without the use of a color filter, and the reasons for this procedure are stated in the *Astrophysical Journal*, **32**, 374, 1910. The parallax work so excellently started at Yerkes by Schlesinger was continued by Slocum and Mitchell, who, in the years 1913 and 1914, published the parallaxes of 61 stars. The photographs discussed by them, and all subsequent photographs with this large refractor, were obtained with the use of a color filter. The work at Yerkes has been continued by Lee, Joy, Van Biesbroeck and others. A complete account of all the parallax results accumulated up to the year 1917 and including 131 stars will be found with bibliography in *Publications of the Yerkes Observatory*, volume IV, part 1.

Consequently, as the present writer realized from his work at Yerkes the importance of a refractor of great focal length in the accurate determination of stellar distances, it was but natural that he should desire to continue the work with the McCormick telescope. This refractor had an aperture of 26 inches instead of the 40 inches of the Yerkes instrument, and moreover its



The 26-inch Clark Refractor.

focal length was only about one half that of Yerkes, 32.5 feet against 62.5 of the larger instrument. However, in discussing with my co-worker and friend Slocum the possibility of obtaining parallaxes comparable in accuracy with those of the 40-inch, we came to the conclusion that the accuracy of the two instruments might be nearly the same, in spite of the much greater focal length of the larger instrument. The reasons for this belief are readily stated. In photographing with any telescope under average conditions of seeing, the image of a star is not a point but an area of greater or less extent depending on the focal length of the telescope, the quality of the objective and the character of the seeing. If the "seeing" is bad, the star images are discs of appreciable size; if the quality of the seeing is "good," the star images are smaller; and if the seeing is "excellent," the star images may be quite small. With object glasses of the finest excellence, the star images under constant conditions of seeing, are smaller in diameter with the instrument of shorter focal length. Consequently, under *average* conditions of seeing, the star images with the 26-inch McCormick telescope are much smaller than those with the 40-inch Yerkes, being as a matter of fact about one half the diameter, or in fact roughly approximating to the ratio of their focal lengths. Under *average* conditions of seeing therefore, since the light from the larger object glass is spread out into a larger circle, the time necessary to obtain a star of certain magnitude (say the 12th) is approximately the same with the 26-inch as it is with the 40-inch. When the photograph under average conditions is measured in order to obtain the position of the stars, it is possible to set a micrometer wire a little more accurately on the smaller image, and consequently this increase in accuracy of setting may almost compensate for the difference in focal length of the two instruments.

All that is said above refers only to *average* conditions of seeing. When the seeing is extraordinarily good the time of necessary exposure is shorter with the larger refractor and the accuracy of results is greater, but under *average* conditions this does not seem to be the case, and as a rule the series of plates necessary

for the complete discussion of most of the parallax regions are taken under average conditions of seeing.

The methods followed in the determination of stellar parallax at the McCormick Observatory are those of Schlesinger with some slight modifications in the matter of detail.

Photographic Apparatus.

The McCormick object glass has an aperture of 26¼ inches with a focal length of 32.5 feet, a ratio of aperture to focal length 1: 15. A Hartmann test has never been applied, though in 1913 a diaphragm was made in order to obtain the necessary photographs. The photographs, however, have never been taken, for it seemed wiser to spend the limited time of the rather small staff of the observatory in measuring parallax plates rather than in measuring photographs to test an objective which both visual observations and photographs show to be a lens probably unsurpassed in excellence. The writer was fortunate in the fact that Professor John A. Miller, the director of the Sproul Observatory, had recently had constructed by the John A. Brashear Co., a plate-holder attachment for his 24-inch refractor. A description of this plate-holder is found in *Popular Astronomy*, **21**, 252, 1913. Accordingly, a contract was entered into with the Brashear Co. to make an exact duplicate of the Swarthmore plate-holder with modifications in detail occasioned by the difference in focal length, etc. This plate-holder was delivered in May, 1914.

The writer was again fortunate in finding a steel tube on the Clark mounting, now rather old, so that it was a comparatively simple matter to attach the plate-holder to the telescope tube. To carry the other apparatus that is used with a refractor, the filar micrometer, the photometer, the visual eyepieces, etc., another attachment was constructed. The change from the photographic plate-holder to the tail piece used in other lines of work is a matter of about ten minutes. Although made of aluminum, the plate-holder weighs about 80 pounds, so that a carriage is used to hold this when not attached to the telescope. To make the change, the telescope is pointed to the zenith, the McCormick Observatory not being provided with an elevator

floor as is found in many observatories with refractors of similar size.

The writer here wishes to express his appreciation of the care exercised by Professor Miller in designing his plate-holder and to the Brashear Co. for making such an excellent attachment. Four metallic plate-holders are provided, though in practice only one is used.

The plate-holder is of the double slide variety devised by Ritchey for the Yerkes refractor, and described in *Astrophysical Journal*, **12**, 355, 1900. It will, therefore not be necessary to describe it in detail here.

Although this photographic attachment was delivered in May, 1914, and was then thoroughly tested and slight imperfections rectified, few plates were secured during the summer and it was not till the fall of 1914 that parallax work was begun with any energy. The result of five year's work in this field of investigation is the parallaxes of 260 stars.

It might be interesting to remark that although the McCormick telescope is practically a duplicate of the 26-inch refractor of the U. S. Naval Observatory the lens is still in its original Clark mounting. The Washington glass, however, was many years ago placed in a modern mounting by Warner and Swazey. The McCormick mounting is very light in weight compared with a Warner and Swazey mounting, so that it is indeed fortunate that in Virginia there is at night very little wind.

Photographic Methods.

In order that as few distortions as possible be introduced into the photographs to be measured to determine the parallax of a certain star, it is necessary that the telescope be used in nearly the same position for each of the plates taken. Consequently, Kapteyn, Russell and Schlesinger each in turn give certain rules to be observed in photographing, which rules will be found on page 12.

The McCormick plates have always been taken with the telescope west of the pier, not a single parallax plate being taken with the telescope east. South of declination + 20°, the telescope will swing past the pier, but north of this declination it

will go only five or ten minutes beyond the meridian. An attempt has always been made to photograph the star when as near the meridian as possible, and in the first table connected with the detailed measures of each star, is given the hour angle at the middle of the exposures for each plate. By reference to these tables, it will be seen that the majority of the plates were taken within half an hour of the meridian, while it is only in comparatively rare cases that the telescope was ever used as far from the meridian as one hour.

Instead of taking four images of the star on each plate as Russell has done, or three images as Schlesinger did at Yerkes Observatory and later at Allegheny Observatory, the McCormick plates in nearly every case had only two images impressed on them. Occasionally, but very rarely, three images were made, and more frequently but still quite rarely, there was only one exposure, the second being stopped by clouds, etc. Ordinarily, two separate plates were taken of the same region in succession, this being done in order to save the time lost in shifting the telescope from one region to the next. Since 1915, two separate regions have been photographed on the same plate. Thus the number of plates necessary to handle and develop was cut in two. The only drawback to this method is the possibility of the image of a star from one region being superimposed on an image in another region. The chance of this happening, however, is small. As a matter of fact such a superposition of images has not happened even once in the more than 8,000 photographs taken to date. It should be unnecessary to remark that the cost of plates is likewise cut in two.

The procedure at the telescope is practically identical with that followed at the Yerkes Observatory. The observing program is kept on a series of cards. On each card appears the star's name, its right ascension and declination for 1920, the magnitude, the spectral type, the proper motion, the number in the B. D., Boss's Preliminary General Catalogue, etc. In brief, the card gives the reasons why this particular star was placed on the observing list. On the lower right hand corner is copied from the B. D. charts for purposes of ready identification, a drawing on the same scale as the charts, and this drawing shows the field

as it appears in the finder of five inches aperture. Also on the card is given the setting of the guiding eyepiece, the opening of the sector, the position of the parallax star behind the sector, and the length of exposure. On each card is kept likewise a record of the plates taken on each region, the number of each plate and the quality of each plate being recorded, in black ink if the plate was taken before midnight and in red ink if after midnight. After a little practice, it is a comparatively simple matter to set the telescope on the star and begin the exposure.

The McCormick Observatory does not have a rising floor, but this does not seem a serious handicap with which to contend. On account of the small size of the observatory staff, only one observer at a time works with the telescope, and not two as at Yerkes Observatory. As already stated, two plates are taken in succession on each region, and two separate regions on each plate, a matter which can be readily accomplished by changing the plate in between the two separate sets of exposures to the same region. Occasionally, one region only is put on a plate, but at other times three separate regions or even four appear on a plate.

The McCormick dome has the peculiarity of having three separate slits all on the same vertical circle, instead of a single slit, as is the case with most domes. At times this is a handicap, but on the other hand by making out the night's observing program beforehand, stars both north and south of the zenith can be observed with a minimum of motion to the dome.

Photographic work is started each evening as soon as it is sufficiently dark. By the use of a color filter and isochromatic plates, it is possible to begin considerably earlier than if the telescope were a photographic one and ordinary plates were used. Work is started ordinarily thirty minutes after sunset, and stopped thirty minutes before sunrise. Near the midnight hours when the parallax factor is less than 0.5, the telescope is available for other lines of research. Practically, as many plates must be taken after midnight as before midnight, or in other words, the number of plates available for a parallax measurement amounts approximately to twice the number that are taken after midnight; the plates just after sunset and just be-

fore sunrise being the most important since their parallax factors are the largest. As a matter of fact, parallax work costs a great many hours loss of sleep, and it is therefore a difficult research for one to carry on who in addition to this work must engage in university teaching. As mentioned above, an attempt was made to photograph only when the parallax factor was greater than 0.5, but occasionally, on account of cloudy weather, etc., especially during the short summer nights, plates were taken with a smaller parallax factor.

Elimination of Errors of the Photographs.

The size of plate used is 5 x 7 inches. Since the scale of the photographs is 1 mm = 20″.8, the plate covers an area in the sky approximately one degree by three quarters of a degree, the longer side of the plate being placed parallel to the equator. In photographing the sky there is projected on a surface more or less plane a portion of the celestial sphere. In this projection there are certain distortions, some being caused after the ray of light from the star reaches the objective, the instrumental distortions, and others which happened beyond the objective.

The super-refinement referred to by Gill which is required in parallax work demands a careful survey of the errors brought into the photographs by these distortions, and the provision of methods for the automatic elimination of as many errors as possible.

Among the distortions beyond the telescope are the following, caused by:

1. Refraction.
2. Aberration.
3. Precession.
4. Nutation.

These above cause changes in the apparent places of the stars.

After the ray reaches the objective there may be errors caused by:

1. Optical distortions by the objective.
2. Lack of perfect collimation of the objective.
3. Change in centering.
4. Change in scale-value.

5. Change in orientation of plate.

In addition to the above two classes of distortions must be added those of the photographic plate, caused by:

1. Photographic plate not being perpendicular to the collimation axis.
2. Plate being not exactly plane.
3. Slipping and distortion of the photographic film.

After the photographic plate is developed, it is placed under a microscope and the positions of the stars are measured, usually in two directions at right angles which we call x and y coördinates. If the x-coördinate is measured parallel to the celestial equator we must be able to transfer from measures in x and y to right ascension and declination.

To obtain parallaxes as near perfect as possible it is necessary to eliminate all errors of measurement of the plate and also all errors caused by distortion both instrumental and non-instrumental.

Turner was the first to show that except at great zenith distances all non-instrumental errors, refraction, aberration, precession, and nutation, can be represented by functions of the measured coördinates which are practically linear.

Turner also showed how to allow for errors of centering, orientation, and scale of plate. If a is the correction to the scale value, then the correction in the measured coördinate X is aX, while the correction for orientation b is bY, and the correction for center is the constant c applied to all the measures, X and Y being the measured rectangular coördinates. Consequently, the measured coördinate X for each star needs a correction $aX + bY + c$. Similarly, measured coördinates in Y demand a correction $dX + eY + f$, where d is the correction for orientation, e that for scale-value, and f the zero-point correction.

Since the corrections for refraction, etc., are linear, they are also of the form $aX + bY + c$. As Turner pointed out, the corrections for refraction, etc., are automatically applied when we determine the quantities a, b and c from the measures themselves. If the area of the sky covered by the plate is sufficiently large, it would be necessary to take into account terms in X^2, Y^2 and

XY, and possibly also terms of higher order. The X-coördinates in the present plates are less than a half-degree from the center of the plate. On account of the limited area covered by these plates, it has not been thought necessary to take account of the very small corrections brought in by second and higher order terms.

In the McCormick plates, the X-coördinate was always placed parallel to the equator, so that X is in the direction of right ascension, and Y in declination. The parallactic shifts in right ascension only were measured, or, in other words, the shifts in the X-coördinate. It was unnecessary, therefore, to decide whether the scale-value and orientation in the directions X and Y were the same or different.

The quantities a, b and c are constants for each plate, and from each plate these quantities must be derived from the measured coördinates, and these coördinates must be corrected accordingly. There is no interest attached to the plate-constants a, b and c, and their computation entails considerable time. Parallax workers are under a great obligation to Schlesinger for showing that it is unnecessary to determine these constants since the same results can be derived from reducing the plates by the method of "dependences." For a complete description of this method, see *Astrophysical Journal*, **33**, 161, 1911. See also *Sproul Observatory Publications*, **4**, 23.

Guiding Error.

Kapteyn was the first to call attention to the importance of eliminating as fully as possible the effects of "guiding error." While the exposure of the plate is being made, it is impossible to keep the guiding star always perfectly bisected, imperfections of the clock-work, the rate of the clock, etc., causing small excursions of the star from the center of the cross-wires of the guiding microscope. This will cause the image of each and every star on the plate to make small excursions from the mean position. If the star being photographed is faint, and the guiding good, then the impressions on the plate caused by the departure of the star from the mean position will be so comparatively faint that no evidence will be visible on the photo-

graphed plate. The question is entirely different with a bright star, for even a small drift will leave a visible impression on the plate, and if the telescope has a tendency to drift caused by the clock not being exactly rated, then the center of brightness of the bright star may be shifted by a small amount due to imperfections in guiding. If, therefore, the stars to be measured on the photograph differ in brightness, the measured coördinates may be affected by errors in guiding. If, on the other hand, the measured stars are all of the same brightness, then guiding error will affect each alike and there will be no relative shift. These considerations point the way to the method of practically eliminating the effects of guiding error.

In the photographic method the position of the parallax star is referred to several stars, which shall be called "comparison stars," usually fainter. The shift of the parallax star with respect to the comparison stars is measured, and thus is found the parallax of the star under consideration relative to the average of the set of comparison stars chosen. The photographic method, therefore, gives the "relative parallax." To eliminate guiding error as fully as possible the comparison stars should be each of nearly the same brightness, and consequently the size of the image of each on the photographic plate will be nearly the same. The image of the parallax star must be of the same size as that of the average comparison star if the guiding error is to be eliminated, and the more nearly this equality in the size of the measured star images is approximated the more nearly will the ill effects of errors of guiding be eliminated from the results.

Although Russell used a small piece of dyed gelatine to cut down the brightness of the parallax star, Schlesinger was the first to realize the importance of making the image of the parallax star on the photographic plate the same size as the average comparison stars. To accomplish this result, a small disk was made to rotate as close to the photographic plate as possible. The disk was made in two halves so that any angular opening up to 180° could be secured. The disk is rotated by means of a small electric motor. On the edge of the disk is graduated a scale, either in degrees, or in hundredths of the circumference. If the image of the parallax star is placed behind the rotating

disk and this disk is rotated, then the light from this star reaches the photographic plate only when it passes through the opening in the sector. By regulating the size of the sector opening, the brightness of the parallax star can be reduced at will. Thus, if the opening in the disk is one-hundredth part of the circumference, the brightness of the parallax star is reduced 100 times, or 5 magnitudes. Since the jaws of the sector are radial, it is obvious that the opening of one-hundredth will reduce the brightness of the star by the same amount no matter what the position of the image of the star behind the sector, or the speed at which the sector is driven. It was at first feared by Schlesinger that if the sector opening were made quite small, the image of the star might be altered from its position by diffraction through the small aperture. These fears have since been found to be utterly unfounded. By the use of such a rotating disk it has been found possible to reduce the brightness of the parallax star as much as 7 magnitudes.

The McCormick telescope is provided with a rotating disk with the scale graduated to hundredths of the sector opening. The average brightness of the McCormick comparison stars is approximately the tenth magnitude on the B. D. scale. Consequently, it was possible with the rotating sector to make the image of the parallax stars of third magnitude or fainter to be equal in size to the average comparison star. For first and second magnitude stars, the equality in size of image could only be approximated with the rotating sector, and accordingly, for the brightest stars some mechanical device must be employed to still further reduce. Various methods may be employed. The simplest perhaps is to have the rotating sector to consist of two separate disks so geared that they will rotate on the same hub at different speeds. When such a double sector is employed the light from the star can reach the photographic plate only when the two sector openings come together. In other words, instead of the light from the star reaching the plate at each rotation of the single disk, the light from the star reaches the plate much less frequently, and as a result, the photographed image of the parallax star will consist of much fewer impressions when the double disk is utilized than when the single disk is

used. Herein, however, may lie a possible source of guiding error in photographing the brightest stars with the double sector. Even though the guiding may be as perfect as possible, the comparatively few impressions of the bright star permitted by the double sector may be made at instants when the guiding may be sensibly different from the average of the guiding from which results the impressions of the comparison stars.

The McCormick Observatory is provided with a double rotating sector designed and constructed by Dr. L. G. Hoxton, of the University of Virginia. It was used to obtain photographs of Sirius. Although the images of Sirius were round, small, and equal in size to the comparison stars, the measures of the different plates were not in satisfactory enough agreement to warrant the continuation of the series of plates for the determination of the parallax of Sirius. The double sector was used to obtain some of the plates of Aldebaran, Altair and Procyon. All other regions of the present series were secured by the single sector, whenever a sector was necessary. The experience with the double sector shows the necessity of rotating the single sector at as high a rate as possible in order to have the image of the parallax star consist of as many impressions as possible. Similar conclusions have been reached by Schlesinger, *Publications of the Allegheny Observatory*, **4**, 12.

At Allegheny Observatory a diffraction grating has been placed over the objective for the purpose of obtaining the parallaxes of the brightest stars. For the results secured, see *Publications*, **4**, 15. Kapteyn's ingenious device of securing an out-of-focus photograph of a region, and then utilizing this negative as an absorbing medium has not been tried at the McCormick Observatory. Experiments with other methods are in progress.

On beginning a series of plates for parallax the first plate secured is carefully examined to see whether a proper system of comparison stars can be secured, and whether the sector opening used has resulted in the equality of images of the parallax and comparison stars. Unless these conditions can be satisfied, the region is abandoned and the star removed from the parallax program.

Choice of Comparison Stars.

In the reduction of the measures of the plates in X-coördinates, there are three plate-constants, a, b and c. Consequently, three comparison stars at least must be used. What is the best number? It is obvious that with an increase in the number of comparison stars there will be a consequent reduction in the size of the accidental errors, and also a reduction resulting from the fact that one of the comparison stars may have a parallax of appreciable size. The time and labor consumed in the measurement of the plates increases with the number of stars measured. When will the accuracy accruing from the additional comparison stars no longer warrant the extra time spent in measurement? In the measurement of the Cambridge plates, Russell adopted wherever possible eight comparison stars. A similar selection is followed by Van Maanen in the work with the 60-inch reflector at Mt. Wilson. On the other hand, at the Allegheny Observatory sixty per cent. of the plates in the first series of fifty parallaxes had four comparison stars, while forty per cent. had only three.

The practice at the McCormick Observatory has been to select five comparison stars when possible. If a suitable five could not be found, then either four or six were chosen. Occasionally a satisfactory grouping could be found only with a selection of three stars. In a few cases seven or eight stars were chosen for comparison stars. The average number of comparison stars for all the regions under investigation has been 4.5.

The conditions for the selection of the comparison stars are:

1. That they shall each be of the same magnitude and also equal in brightness to the parallax star reduced by the rotating sector. The more nearly this condition is fulfilled the more nearly will the results be free from systematic errors.

2. That the center of position, or centroid, of the system of comparison stars shall coincide as nearly as possible with the position of the parallax star.

How nearly these two conditions are fulfilled may be seen from the tables attached to each star, where under the head "Com-

parison Stars" are given the diameters in millimeters of the star images measured on the plates, and also the X and Y coördinates of the parallax star and each comparison star referred to the center of position of the comparison stars.

Methods of Measurement.

In order to eliminate personal errors as much as possible, all plates were measured direct, and reversed 180°.

Measuring engines of two types were used. Through the kindness of Dr. Harold Jacoby, Rutherfurd Professor of Astronomy at Columbia University a measuring machine was loaned to the McCormick Observatory as soon as the first photographic plates were taken. At the beginning of the work, this was the only machine used. In 1916, a machine was purchased from Wm. Gaertner and Son, an engine exactly similar to those purchased at the same time by Allegheny, Yerkes and other observatories. In 1917, a second Repsold machine was loaned by Professor Jacoby.

The McCormick Observatory is under a great debt to Professor Jacoby and to Columbia University for their kindness in lending these measuring machines, and due acknowledgement is accordingly made. Likewise our thanks are to be expressed to Dr. Frank Schlesinger, who more than anyone else was responsible for the excellent design of the Gaertner machine.

The instruments obtained from Columbia University were made by Repsold. They were used at Columbia in the measurement of the Rutherfurd photographs. Their construction and method of use are fully described in the *Contributions from the Observatory of Columbia Uuiversity*. A description need not be given here. The method of measurement consists in bringing the star to be measured in the center of the field of view of the measuring microscope and close to and just above the horizontal wire. The star is now bisected by the vertical wire, and the head of the micrometer read. By turning a lever, the microscope is rotated so as to point at a scale graduated on silver to millimeters. The microscope is again pointed at the star, and its image is again bisected. In bisecting the star, a single vertical wire is used, but in reading the millimeter scale a double

wire is employed. Two turns of the micrometer head are equal to a millimeter. The micrometer was read by estimation to tenths of a division. In each reading of the position of a star, two bisections were first made on the star, then two on the millimeter scale, and again two on the star. The reading, therefore, consisted of four readings on the star and two on the scale. An objection might be made to this method of measurement that there was a possible chance of shift in position of the microscope in turning it from star to scale. In making many thousands of measures, the writer has found no indication of any motion of this sort. The writer always used both eyes in measurement, the right to bisect the star, and the left to bisect the scale. This relieved the strain on the eyes caused partially by difference in illumination of the photographic plate and scale.

The Gaertner machine has been fully described in the publications of the Yerkes and Allegheny Observatories. This machine consists essentially in a long screw which moves a microscope. The position of the microscope can be read directly to the thousandth of a millimeter, and by estimation to tenths, or to the tenth of a micron.

Each type of machine has its advantage, each has its disadvantage. Since there is no scale to read, the Gaertner machine is a faster machine, though the difference in speed is not so great as might first appear. If the same number of bisections of the star are made with both instruments, then the readings of the scale in the Columbia machine would apparently entail this much additional time. Since however, there is much less weight to move, each bisection with the Columbia machine can be made more quickly than is possible with the Gaertner machine; and, in addition, the microscope can be moved from star to star more readily with the Columbia type of machine.

The accuracy in the measurements with the Gaertner machine depends on the accuracy of the screw, its freedom from periodic and non-periodic errors. The errors of the McCormick machine have been investigated by Mr. Alden, and the errors of the screw have been found to be negligible. But no matter how carefully the machine is handled, the screw is liable to wear. Consequently, though a screw may be perfect, errors may gradually

appear. The only part of the Columbia machine that can wear is the very short micrometer screw, and the wear in this will cause errors in the measurements very much smaller in size than those in the long screw of the Gaertner machine. With the Columbia machine the measures are referred to a millimeter scale, and after the errors of this scale have been once investigated there is little chance for any change in the scale. On the whole, therefore, the Columbia machine will stay in adjustment more constantly than the Gaertner machine. In the measurement of the plates taken for parallax with the 60-inch Mt. Wilson reflector, Van Maanen uses a blink microscope. The McCormick Observatory does not possess this form of measuring machine nor any funds with which to buy one.

On one plate of the series to be measured for parallax there is always impressed a trail of a bright star, obtained by stopping the telescope. This trail gives a line on the plate parallel to the celestial equator. On each of the other plates of the series a trail is drawn with ink on the glass side of the plate, the star images of the two plates being superposed. By means of these trails the plates can be readily oriented in the measuring machine. As above stated, the parallactic shifts in right ascension only were measured, so that X-coördinates correspond to right ascension. On one plate of the series, the Y-coördinates were measured in order to obtain the dependences.

At the telescope care was taken to have the parallax star and comparison stars always photographed in as nearly the same position on the plate as possible. This could be readily accomplished by following the directions on the cards, *i. e.*, by using the same guiding star and placing the parallax star under the sector at the same relative position.

In placing each plate of the series in the machine for measurement, after properly orienting the plate, the plate was shifted laterally in the jaws so that the reading of each star should fall always on the same division of the scale, if one of the Columbia machines were used, or at the same reading of the screw for the Gaertner machine. As before stated, two images of each star were usually photographed and measured on each plate, so that it would be possible to make the adjustments just specified for

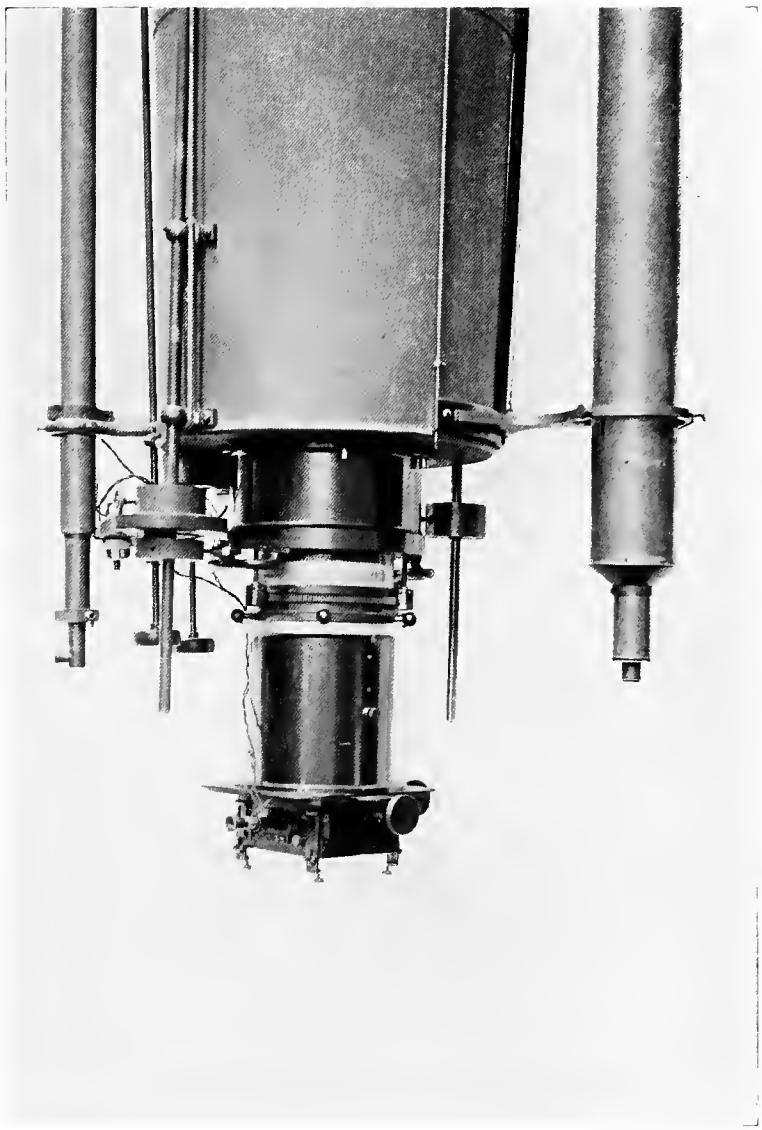
one set of images only. In taking the photographs, however, the guiding eyepiece was always shifted by approximately the same amount, since it was moved from one notch to the next, so that ordinarily always the same part of the scale or screw was used in the measurement of the parallax star and of each of the comparison stars. After measuring the plate direct, it was reversed 180°, and the complete measurement consisted of those made direct and reversed. In the reversed position, the measures for the stars all come at a different part of the scale or screw from the measures direct. Consequently, by using the same divisions of the scale or the same part of the screw always for the measurement for each plate of the series there was thus eliminated all departures from the errors of division of the scale used, or almost equally completely any errors of the screw. It is felt, therefore, that all errors of the machines have been eliminated, and that all personal errors have been largely eliminated except the purely accidental errors of measurement.

After what has been said above, it should be unnecessary to add that in measuring a series of plates to determine the parallax of a star one machine only was used. Under no circumstances can part of the series be measured on one machine and part on another. Since the Columbia machine, No. 1, was for a time the only machine we possessed, more than half of the present parallaxes have been determined from measures with it. Most of the balance of the measures were carried out with the Gaertner engine.

The writer has always felt more confidence in his ability to accurately bisect a star image if this image were well blackened and had a clean crisp edge. Consequently, the exposures at the telescope were lengthened until the star images were satisfactorily blackened.

Reductions of the Plates.

In order to make the thousandths of a millimeter more certain, the measures and reductions were carried out to 0.0001 mm. The measures and reductions of the two sets of images on the plate, images A and B as we called them, were carried out entirely independently, until the "solution" (m) by the method



Double-Slide Plate-Holder.

of dependences was obtained for image A and image B separately. The solution for the plate was then found by combining those for A and B. If the images of the A exposure were better than those of B, then it was given a higher weight when combining, the relative weights of A and B and the weight of the plate being assigned at the time of measurement. In nearly all cases A and B were given equal weight.

In combining the measures direct and reversed, certain checks were devised so as to eliminate any chance of errors in computation. In computing the solutions from the measures, a multiplying machine was used. The McCormick Observatory is under a great obligation to Mr. John Neilson of New York for his gift of one computing machine and his loan for a considerable time of a second machine.

The reductions were always carried out in millimeters, and the results were not converted into seconds of arc until the final values of the parallax and proper motion were obtained.

The solution of each plate (m) is made up of three quantities represented by the equation:

$$c + t\mu + P\pi = m \qquad (1)$$

where π is the value of the annual parallax of the star to be found and P is the parallax factor. In order to eliminate the possibility of errors in the parallax factors their values were found by two different methods. μ is the proper motion in right ascension, or is equal to $\mu_\alpha \operatorname{Cos}\delta$. For the sake of simplicity in reductions μ is the value of the proper motion for one hundred days, and not per year as is ordinarily the case. t is the time in days from any arbitrarily assumed time, usually taken as some date in the middle of the series of plates. c is a plate constant depending on the zero-point, and has no meaning in the sky.

Each plate, therefore, gives an equation in the form (1), in which c, μ and π are unknown quantities, and t, P and m are known. Since the plates have different weights, they are combined into a least-square solution by multiplying each equation by $\sqrt{p}$, p being the weight.

Using the usual notation of least-squares, the normal equations take the following form:

$$\begin{aligned} [p]c + [pt]\mu + [pP]\pi &= [pm] \\ + [pt^2]\mu + [ptP]\pi &= [ptm] \\ + [pP^2]\pi &= [pPm] \end{aligned} \qquad (2)$$

The formation of the normal equations was performed partially by the use of Crelle's tables and partially by the multiplying machine. Each of the coefficients such as $[pt]$, $[ptm]$, and $[pP^2]$ were found by two different methods of computation. For instance, the product ptm is found either by multiplying pt by m or pm by t. Similarly pP^2 can be found by a table of squares in Crelle, or by multiplying pP by P by means of the machine.

The normal equations were solved by the multiplying machine. When the values c, μ and π are found, their values are substituted in the original equations, and the residuals (v) are found. A final check on the accuracy of the computation is found when $[pv]$, $[ptv]$ and $[pPv]$ must each equal zero. This part of the computation was carried out to 0.00001 mm.

The reductions of the first parallaxes were carried out by Mrs. Alfred L. Hall-Quest. Miss Eudora Magill has carried out most of the least-square reductions. The writer wishes to express to her his appreciation of her faithful and efficient services. She was associated with the writer in all of his parallax work at the Yerkes Observatory and with nearly all of it at the McCormick Observatory. It is felt that with the system of checks in the progress of the reductions and with the great care with which the calculations were performed there is little chance of any errors in the work resulting from the computation.

Elimination of Systematic Errors.

The average probable error of the parallaxes of the McCormick series of 260 stars is $0''.009$, which expressed in millimeters is 0.00043. To obtain π with as high a degree of accuracy as possible, its weight in the least-square solution must be as great as possible. By using the Gaussian method of elimination with the above normal equations (2) it will readily be seen that the maximum weight of π is obtained under the following conditions:

(1) p the weight of each plate should be as large as possible.

(2) $[pP^2]$ should be as large as possible.

(3) $[pP]$ should be as small as possible.
(4) $[pt]$ should be as small as possible.
(5) $[pt^2]$ should be as large as possible.

These conditions will be fulfilled under the following circumstances:

(*a*) Each plate should be of as good quality as possible.
(*b*) Each plate should be taken when the parallax factor is a maximum, thus giving a maximum base-line with which to determine the distance.
(*c*) The plates taken after midnight should be as well determined as those before midnight.
(*d*) The series of plates should be as symmetrical as possible with regard to the time.
(*e*) The series of plates should be spread over as much time as possible.

Most of the above are self-evident. If the star's proper motion is to be regarded as an unknown, then the three unknown quantities c, μ and π may be determined from plates taken at three seasons, or after the lapse of one year. In the measurement of the plates it is conceivable that all of the plates taken in any one season might possibly give quantities which are all too large or all too small. Where quantities are to be measured which are such minute fractions of a millimeter as are the stellar parallactic displacements, it is quite possible that the accidental errors of measurement might cause all the values of the measures in one season to be either too large or too small. There is thus the possibility of systematic errors creeping into the parallaxes which for lack of a better name might be called "seasonal errors." If, therefore, the series of plates are allowed to run to a fourth or a fifth season, there will be every chance that the seasonal errors will have much less effect on the final value of the parallax.

In the early part of the work at the McCormick Observatory, an attempt was made to finish the work on a given region in three seasons wherever possible. Most of the parallax results published in *Popular Astronomy*, **25**, 23, 1917, were completed in three seasons. In conference with the other members of the Parallax Committee of the American Astronomical Society, it seemed advisable that the plates should cover five seasons,

and accordingly most of the stars in the list of 83 published in *Popular Astronomy* were again put on the observing program, and new determinations of the parallaxes were made. Consequently, these values already published should be regarded as preliminary values only, and the results should be superceded with these herewith published.

As Schlesinger has already pointed out, the method of allowing the photographs to cover five seasons instead of three does not necessarily entail a greater number of photographs. If 15 plates are to be used in a parallax determination, then if the work were finished in three seasons the plates would probably be taken in number, 4, 7, and 4, in the three successive seasons. Three plates in each of five seasons will give a more reliable value of the parallax.

An additional advantage of allowing the plates to cover five seasons, or two years, instead of concluding them in three seasons, or one year, is that the proper motion is more accurately determined.

Most of the McCormick parallaxes, therefore, result from the measures of photographs which cover five seasons. It is believed that systematic errors of all kinds have been pretty thoroughly eliminated. How fully this elimination has been accomplished will be seen later.

Proper Motions.

A valuable by-product resulting from the measures of the plates is the determination of the proper motions. These proper motions are relative and furnish the difference in proper motion between the parallax star and the average proper motion of the comparison stars. On the other hand, the meridian circle gives proper motions which are absolute, or which are referred to the system of the stars as a whole. The proper motions determined from the plates may differ from those derived by meridian circle for three reasons: (*a*) On account of errors in the photographic measurements; (*b*) on account of errors in the meridian circle positions; (*c*) on account of motions of the comparison stars with respect to the stellar system.

As already stated, in most of the regions the plates have been allowed to cover a period of two years, and for such a series the proper motions are determined with a probable error 0″.01. For the stars under investigation visible to the naked eye comparisons are made with the *Preliminary General Catalogue* of Boss. Most of the fainter stars are found in Porter. The results will be found in Table.

The meridian circle results are not infallible, the position of a star can be known only within a certain limit of error. For the early catalogues, these errors may be quite large. In the catalogue of Boss the probable errors of the determination of the proper motions are given. Porter furnishes the original observations and the positions brought up to the epoch 1900, from which the probable error can be readily determined. The earliest accurate star catalogue is that of Bradley for the epoch 1755. A comparison of the accuracy of visual work by means of the best meridian circles of the present day with photographic work by telescopes of great focal length may be gained when one realizes that proper motions can be determined from photographs stretching over an interval of two years with quite as high a degree of accuracy as from meridian circle observations from the earliest times of exact measurements up to the present, *i.e.*, 165 years. After a lapse of a few years, say ten years, additional photographs may be taken to determine the proper motions with a higher degree of precision, if such is necessary. A few photographs of each region will be entirely ample for the purpose and a probable error 0″.002 will result. If such photographs are made, then, on account of the errors in the early catalogue positions it will be impossible to attain an equal degree of accuracy with the meridian circle until after the lapse of at least another century.

On account of the solar drift, the stars of tenth magnitude used as comparison stars may have a parallactic drift. As Schlesinger has pointed out, *Publications of the Allegheny Observatory*, **4**, 1, a comparison of photographic and meridian circle proper motions will give valuable material regarding the relation of proper motion to brightness and to star streaming.

A fourth cause of difference between photographic and meridian circle proper motions will result from orbital motion of stars forming a physical system. As will be shown later, this will afford a means of determining the relative masses of the stars forming a physical system. In the Table such differences of proper motion are found in the stars η Cassiopeiæ, 70 Ophiuchi, Krueger 60, etc.

Other large differences in this table between proper motions from catalogue and from photographs can be explained by errors in the positions of the early catalogues. For instance, in the star Lalande 1799, there is apparently an error in right ascension in the catalogue by Lalande.

Spectroscopic Parallaxes.

One of the most important investigations that have taken place in recent years is the determination by Adams of the distances of the stars by means of the spectroscope, *Proceedings of the National Academy of Sciences*, **2**, 147, 152, 1916. By comparing the relative intensities of certain lines in the spectra of stars, Adams is able to determine their absolute magnitude or, in other words, the magnitude that the stars would have if placed at a distance where the parallax would be equal to $0''.1$. By means of the formula $5 \log \pi = M + m - 5$, where M is the absolute magnitude, m the apparent magnitude and π the parallax in seconds of arc, Adams has been able to derive parallaxes. These values are absolute in value and are not relative to a particular system of comparison stars. It should be pointed out that the spectroscopic results of Mt. Wilson are based on the measured or trigonometric parallaxes, and that the accuracy of the spectroscopic parallaxes is increased as the measured parallaxes are increased in number and accuracy. *The Luminosities and Parallaxes of Five Hundred Stars* published by Adams and Joy, 1917 (*Contributions from the Mt. Wilson Observatory*, 142) were founded on the system of parallaxes then published. Since then many parallaxes have been determined by photography and their results have been communicated to Adams and Joy in advance of publication. These recent parallaxes have been furnished chiefly by Mt. Wilson, Yerkes, Allegheny, Sproul, and McCormick Observatories. Dr. Adams has kindly informed the

writer that at Mt. Wilson there are about 1800 parallaxes spectroscopically determined. These parallaxes, in advance of publication are given for all of the stars on the McCormick list except those of early spectral type, for which as yet Mt. Wilson can furnish no values. As will be shown later, the early trigonometric parallaxes, those due mostly to heliometer and meridian circle, are subject to large errors. On the whole these early parallaxes are too large in size. As a result, the Mt. Wilson "500" parallaxes are based on a system different from the more recent results. A comparison of the "500" with the recent results shows considerable differences in some of the individual stars. The recent spectroscopic parallaxes are on the average 0".005 smaller than those in "500" stars.

The average magnitude of the comparison stars used in the McCormick measures is about 10 on the B. D. scale. It has been assumed that the average parallax of the comparison stars is 0".005. To compare the absolute parallaxes of Mt. Wilson with the relative values in the Table, 0".005 has been subtracted from the Mt. Wilson results.

The Detailed Results.

In the early years of parallax work, stars were ordinarily observed only when it was expected they would show an appreciable parallax. Thus there were specially investigated stars with large proper motions. The observing program of the McCormick Observatory has attempted a more representative selection of stars. The main part of the program consists of all stars of F, G, K and M types brighter than 4.50 magnitude, and all stars of the earlier types brighter than magnitude 4.00 and north of declination $-20°$. These stars formed the backbone of the program. To these were added stars whose parallaxes by meridian circle or heliometer gave discordant results, and also some interesting visual binaries, stars of the 61 Cygni type, etc. Our observing program was sent on cards to the Allegheny, Dearborn, Sproul and Yerkes Observatories, and in turn their lists were sent to the McCormick Observatory. In this manner each was kept advised of the program of the other so that sufficient duplication could be made, but excessive duplication avoided.

Below, under the details for each star, are given the reasons why the star was observed and anything of particular interest concerning the star. Following a brief description, there are added in Table I, the details of the plates taken, their serial number, date, hour angle at the middle of exposure, observers, and quality or weight. In nearly all cases, two images were exposed on each plate. A good plate was given a weight 1.0, a fair plate 0.7, and a poor plate 0.4. A plate of one good image received a weight 0.7.

The observers taking part in the work at the telescope were:

M = S. A. Mitchell.
Ol = C. P. Olivier.
A = H. L. Alden.
G = P. H. Graham.
L = R. C. Lamb.
B = G. B. Briggs.
Ds = P. A. Dales.
D = Marguerite D. Darkow.
H = M. Alberta Hawes.
F = Jennie V. France.

Under the table of "Comparison Stars" there is given for comparison stars and parallax star their diameters in millimeters, the X and Y coördinates measured from the center of position of the comparison stars, and the dependences of the comparison stars.

In Table II are given the residuals in millimeters, and the weighted residual in seconds of arc. The scale value of the photographs is 20″.8 per millimeter.

The value of μ given by the least-square solution is the proper motion in right ascension, or $\mu_a \mathrm{Cos}\delta$. These values are given in the following units: (*a*) in millimeters per one hundred days, (*b*) in seconds of arc per one hundred days, and (*c*) in seconds of arc per year.

β CASSIOPEIÆ ($0^h\ 3^m$; $+58°\ 35'$)

This star is interesting on account of the proper motion of 0″.55. This large proper motion has caused the star to be many times investigated for parallax. The star is of magnitude 2.42, and of F5 type. The rotating sector was used to reduce the brightness on the photographic plate. Twenty-eight plates were measured by Mr. Mitchell.

TABLE 1

PLATES OF β CASSIOPEIÆ

No.	Date.	Hour Angle.	Observers.	Weight.
152	1914 July 21	$-0^h.1$	M	1.0
512	Nov. 5	−0.2	M	1.0
522	Nov. 6	−0.4	A	0.8
553	Nov. 11	−0.1	M, G	0.8
602	Nov. 21	0.0	M, A	1.0
659	Dec. 12	−0.4	M, Ol	0.7
1554	1915 Aug. 15	−0.2	Ol	0.7
1559	Aug. 18	−1.0	Ol	0.6
1560	Aug. 18	−0.4	Ol	0.5 *
2096	Nov. 30	−0.3	A	0.7
2131	Dec. 9	−0.6	M	0.9
2132	Dec. 9	−0.2	M, A	0.8
2868	1916 Aug. 13	−0.3	Ol	0.9
2869	Aug. 13	+0.1	Ol	0.6
2954	Sept. 3	−0.1	A	1.0†
2965	Sept. 4	+0.1	L	0.8
3421	Nov. 21	−0.4	L	1.0
3422	Nov. 21	−0.1	M	1.0
3440	Nov. 26	−0.3	M	0.7
3496	Dec. 7	−0.6	M	0.9
3497	Dec. 7	−0.3	M	0.7
4282	1917 Aug. 18	−0.5	Ol	1.0
4307	Aug. 20	−0.2	B	1.0
4308	Aug. 20	+0.1	B	1.0
4795	Nov. 19	−0.2	A	1.0
4838	Dec. 2	−0.6	M	0.9
4839	Dec. 2	−0.3	M	0.9
4846	Dec. 5	−0.1	A	0.9

* One exposure. † Three exposures.

TABLE 2

REDUCTIONS FOR β CASSIOPELÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
152	+0.0046	1.0	+0.828	−676	−0.0010	−0″.02
512	+ .0056	1.0	− .602	−569	+ .0014	+ .03
522	+ .0083	0.8	− .614	−568	− .0012	− .02
553	+ .0066	0.8	− .669	−563	+ .0007	+ .01
602	+ .0072	1.0	− .764	−553	+ .0005	+ .01
659	+ .0140	0.7	− .886	−532	− .0052	− .09
1554	+ .0304	0.7	+ .585	−286	− .0005	− .01
1559	+ .0314	0.6	+ .548	−283	− .0014	− .02
1560	+ .0325	0.5	+ .548	−283	− .0025	− .04
2096	+ .0342	0.7	− .829	−179	− .0009	− .01
2131	+ .0350	0.9	− .875	−170	− .0012	− .02
2132	+ .0343	0.8	− .875	−170	− .0005	− .01
2868	+ .0552	0.9	+ .599	+ 78	− .0002	.00
2869	+ .0509	0.6	+ .599	+ 78	+ .0042	+ .07
2954	+ .0535	1.0	+ .316	+ 99	+ .0022	+ .05
2965	+ .0541	0.8	+ .301	+100	+ .0016	+ .03
3421	+ .0532	1.0	− .769	+178	− .0049	+ .10
3422	+ .0584	1.0	− .769	+178	+ .0003	− .01
3440	+ .0547	0.7	− .807	+183	+ .0037	+ .06
3496	+ .0578	0.9	− .870	+194	+ .0012	+ .02
3497	+ .0530	0.7	− .870	+194	+ .0060	+ .10
4282	+ .0824	1.0	+ .541	+448	− .0020	− .04
4307	+ .0832	1.0	+ .515	+450	− .0027	− .06
4308	+ .0781	1.0	+ .515	+450	+ .0024	+ .05
4795	+ .0843	1.0	− .750	+541	− .0010	− .02
4838	+ .0866	0.9	− .844	+554	− .0027	− .05
4839	+ .0848	0.9	− .844	+554	− .0009	− .02
4846	+0.0886	0.9	−0.859	+557	−0.0046	−0.09

The normal equations are:

$$23.8c + 4.770\mu - 6.7510\pi = + 1.1564 \text{ mm.}$$
$$391.7264\mu - 3.0927\pi = + 2.9247 \text{ mm.}$$
$$12.0855\pi = - 0.3116 \text{ mm.}$$

from which:

$c = +0.04800$ mm.
$\mu = +0.00690$ mm. $= +0''.1436$, or $+0''.524$ per year.
$\pi = +0.00279$ mm. $= +\mathbf{0''.058 \pm 0''.011}$
Probable error of plate of unit weight
± 0.00166 mm. $= \pm 0''.034$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−47.9	+25.4	+0.223
2	.11	+10.2	−38.2	.269
3	.09	+13.8	−43.2	.273
4	.09	+23.9	+56.0	+0.235
Parallax star	0.20	+ 1.46	− 3.27	

The following values of the parallax have been found:

Parallax.	Authority.	Method.
$+0''.154 \pm 0''.035$	Pritchard	Photography
$+ .161 \pm .028$	Kostinsky	Prime Vertical
$+ .10 \pm .029$	Flint	Meridian Circle
$+ .082 \pm .009$	Russell	Photography
$+ .051 \pm .015$	Smith	Heliometer
$+ .065 \pm .081$	Jewdokimov	Meridian Circle
$+ .074 \pm .011$	Allegheny	Photography
+0.060	Adams	Spectrograph

The McCormick value for the annual proper motion in right ascension, or $\mu\alpha \cos \delta$ is $+0''.524$, while that due to Boss's Preliminary General Catalogue is $+0''.529$.

PIAZZI 0^h 130 (0^h 32^m; $-25°$ 19′)

This star is called also 82 Ceti, and it is a double β 395. According to Burnham, "this interesting system was discovered with the 6-inch, and it was evident from the first that it was a

TABLE 1

PLATES OF PIAZZI 0^h 130

No.	Date.	Hour Angle.	Observers.	Weight.
2183	1915 Dec. 21	$-0^h.3$	M	1.0
2184	Dec. 21	+0.1	M	1.0
2195	Dec. 22	−0.7	M	0.9
2228	Dec. 26	0.0	M	0.9
2920	1916 Aug. 25	−0.1	A	1.0
2921	Aug. 25	+0.2	A	1.0
2955	Sept. 3	0.0	A	1.0
2956	Sept. 3	+0.6	A	1.0
2969	Sept. 5	−0.4	M	0.5*
2983	Sept. 9	−0.3	M	1.0
3387	Nov. 16	−0.2	L	1.0
3388	Nov. 16	+0.2	L	0.8
3475	Dec. 2	−0.3	A	1.0
3476	Dec. 2	+0.1	A	1.0
4248	1917 Aug. 5	−0.5	A	0.9
4297	Aug. 19	+0.1	Ol	0.8
4298	Aug. 19	+0.5	Ol	0.9
4328	Aug. 24	−0.8	B	0.9
4329	Aug. 24	−0.4	B	1.0
4842	Dec. 2	+0.6	M	1.0
4843	Dec. 2	+1.0	M	0.8
4852	Dec. 6	−0.3	A	1.0

* One exposure.

physical pair from the large proper motion of the components." The total proper motion is 1″.40 per year. The radial velocity is + 17.2 km. per second, and the type G5. The only trigonometric parallax is that of Flint who, by the meridian circle finds the value + 0″.34 ± 0″.060. Recently, Adams by means of the spectroscope derives the parallax + 0″.095. In *Lick Observatory Bulletin*, **3**, 88, 1905, Aitken derives the orbit, and finds a period of 24.0 years. Since the distance separating the pair is always less than 0″.8, and the magnitudes very nearly

TABLE 2

REDUCTIONS FOR PIAZZI 0^h 130

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2183	+0.0028	1.0	−0.890	−367	+0.0010.	+0″.02
2184	+ .0023	1.0	− .890	−367	+ .0015	+ .03
2195	+ .0028	0.9	− .893	−366	+ .0012	+ .02
2228	+ .0066	0.9	− .901	−362	− .0019	− .04
2920	+ .0562	1.0	+ .550	−119	− .0009	− .02
2921	+ .0524	1.0	+ .550	−119	+ .0029	+ .06
2955	+ .0570	1.0	+ .430	−110	− .0005	− .01
2956	+ .0568	1.0	+ .430	−110	− .0003	− .01
2969	+ .0626	0.5	+ .402	−108	− .0059	− .09
2983	+ .0602	1.0	+ .344	−104	− .0030	− .06
3387	+ .0640	1.0	− .646	− 36	+ .0016	+ .03
3388	+ .0666	0.8	− .646	− 36	− .0010	− .02
3475	+ .0696	1.0	− .796	− 20	− .0017	− .04
3476	+ .0659	1.0	− .796	− 20	+ .0020	+ .04
4248	+ .1190	0.9	+ .771	+226	+ .0006	+ .01
4297	+ .1195	0.8	+ .629	+240	+ .0021	+ .04
4298	+ .1167	0.9	+ .629	+240	+ .0049	+ .10
4328	+ .1231	0.9	+ .566	+245	− .0008	− .02
4329	+ .1246	1.0	+ .566	+245	− .0024	− .05
4842	+ .1352	1.0	− .795	+345	− .0002	.00
4843	+ .1362	0.8	− .795	+345	− .0012	− .02
4852	+0.1361	1.0	−0.823	+349	−0.0005	−0.01

equal, being 6.6 and 6.7, respectively, the values for π and μ below will be the same as those for the center of gravity of the system. Using Flint's value of the parallax, the mass of the system (*Popular Astronomy*, **18**, 483, 1910), is 0.01. With the McCormick value of the parallax, the mass of the system is 0.68 times that of the sun. The annual proper motion in right ascension from the present series of plates is + 1″.394, while the value from Boss is + 1″.384. The plates were measured by Mr. Alden.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.21	−49.5	−16.4	+0.1297
2	.17	−42.0	+29.5	.1570
3	.19	− 9.4	+50.6	.1865
4	.10	+ 3.4	−45.2	.1461
5	.09	+45.4	−39.2	.1735
6	.18	+52.1	+20.7	+0.2072
Parallax star	0.13	+ 4.41	+ 2.83	

The normal equations are:

$$20.4c - 0.631\mu - 3.0598\pi = + 1.5036 \text{ mm.}$$
$$117.4163\mu + 9.2768\pi = + 2.1480 \text{ mm.}$$
$$9.8561\pi = - 0.0179 \text{ mm.}$$

from which:

$c = + 0.07490$ mm.
$\mu = + 0.01837$ mm. $= + 0''.3820$, or $+ 1''.394$ per year.
$\pi = + 0.00414$ mm. $= + \mathbf{0''.086 \pm 0''.010}$.
Probable error of plate of unit weight
± 0.00144 mm. $= \pm 0''.0300$.

α CASSIOPEIÆ ($0^h\ 34^m$; $+55°\ 59'$)

There is nothing specially worthy of note regarding the brightest star in the constellation of Cassiopeia except that it is a variable with a magnitude range from 2.2 to 2.8, it is of type K, and of small proper motion $0''.06$. A small parallax would be expected. Twenty-two plates of this region were measured by Mr. Mitchell.

TABLE 1

PLATES OF α CASSIOPELÆ

No.	Date.	Hour Angle.	Observers.	Weight.
179	1914 Aug. 16	-1^h0	Ol	0.4*
495	Nov. 4	−0.3	G	0.5*
513	Nov. 5	−0.1	M	0.9
565	Nov. 12	−0.4	Ol	0.7
603	Nov. 21	0.0	M, A	0.9
615	Nov. 22	−0.5	M	0.8
627	Nov. 23	−0.1	Ol, G	0.8
643	Nov. 25	−0.1	M, A	0.7
1533	1915 Aug. 6	−0.3	G	0.7*
1534	Aug. 6	0.0	G	0.6*
1581	Aug. 25	−1.3	A	0.8
1582	Aug. 25	−0.9	A	0.8
2054	Nov. 24	−0.6	G, Ol	0.7
2076	Nov. 27	−0.7	G	0.5
2177	Dec. 19	−0.6	M	0.8
2178	Dec. 19	−0.2	M	0.8
2856	1916 Aug. 1	−0.6	A	0.7
2857	Aug. 1	−0.2	A	0.7
2864	Aug. 12	−0.5	A	1.0
2865	Aug. 12	−0.1	A	1.0
3441	Nov. 26	−0.4	M	1.0
3442	Nov. 26	0.0	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−46.7	−28.6	+0.201
2	.10	−32.0	−33.0	.194
3	.14	−29.6	+52.1	.236
4	.16	+47.3	− 3.7	.182
5	.10	+61.0	+13.2	+0.187
Parallax star	0.22	− 2.6	+ 1.9	

TABLE 2

REDUCTIONS FOR α CASSIOPEIÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
179	+0.0110	0.4	+0.672	−439	+0.0005	+0″.01
495	+ .0079	0.5	− .484	−359	+ .0026	+ .04
513	+ .0094	0.9	− .497	−358	+ .0011	+ .02
565	+ .0093	0.7	− .586	−351	+ .0011	+ .02
603	+ .0114	0.9	− .687	−342	− .0010	− .02
615	+ .0109	0.8	− .697	−341	− .0005	− .01
627	+ .0112	0.8	− .707	−340	− .0008	− .02
643	+ .0101	0.7	− .726	−338	+ .0002	.00
1533	+ .0139	0.7	+ .773	− 84	− .0004	− .01
1534	+ .0135	0.6	+ .773	− 84	.0000	.00
1581	+ .0147	0.8	+ .570	− 65	− .0013	− .02
1582	+ .0149	0.8	+ .570	− 65	− .0015	− .03
2054	+ .0138	0.7	− .714	+ 26	− .0015	− .02
2076	+ .0130	0.5	− .742	+ 29	− .0007	− .01
2177	+ .0129	0.8	− .882	+ 51	− .0006	− .01
2178	+ .0106	0.8	− .882	+ 51	+ .0017	+ .03
2856	+ .0147	0.7	+ .809	+277	+ .0008	+ .01
2857	+ .0141	0.7	+ .809	+277	+ .0014	+ .02
2864	+ .0156	1.0	+ .708	+288	− .0002	.00
2865	+ .0150	1.0	+ .708	+288	+ .0004	+ .01
3441	+ .0151	1.0	− .740	+394	− .0008	− .02
3442	+0.0136	1.0	−0.740	+394	+0.0007	+0.01

The normal equations are:

$$16.8c - 3.593\mu - 2.3769\pi = + 0.2143 \text{ mm.}$$
$$+ 131.8629\mu + 9.3767\pi = + 0.0348 \text{ mm.}$$
$$+ 8.5301\pi = - 0.0159 \text{ mm.}$$

from which:

$c = + 0.01304$ mm.

$\mu = + 0.00054$ mm. $= + 0''.0111$, or $+ 0''.041$ per year

$\pi = + 0.00119$ mm. $= + \mathbf{0''.025 \pm 0''.005}$.

Probable error of plate of unit weight

$$\pm 0.00066 \text{ mm.} = \pm 0''.014.$$

The only values of the parallax so far published are an early one by photography by Pritchard, the mean of four values giving $+ 0''.038 \pm 0''.023$, and a determination by Flint with the meridian circle with the result $- 0''.014 \pm 0''.034$. By the spectroscopic method, Mt. Wilson finds a parallax ranging from $+ 0''.022$ to $+ 0''.028$ depending on the visual magnitude of this variable star. As already noted, the method of Adams gives *absolute* values of the parallax, while the McCormick results are *relative* to the particular system of comparison stars used. To reduce the relative parallax of α Cassiopeiæ to an absolute value, $0''.005$ should be added to the McCormick value. The proper motion in right ascension from the present series of plates is $+ 0''.040$ per year. Boss gives $+ 0''.051$.

54 PISCIUM ($0^h\ 34^m$; $+20°\ 42'$)

This star of magnitude 6.08 and of spectral type K has a total proper motion $0''.61$. The parallax was first determined at

TABLE 1

PLATES OF 54 PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
3480	1916 Dec. 5	$-0^h.1$	L, M	0.6
3517	Dec. 10	−1.2	M	1.0
4330	1917 Aug. 24	+0.3	B	0.7
4331	Aug. 24	+0.9	B	0.7
4380	Sept. 1	−0.6	B	0.9
4381	Sept. 1	−0.2	B	1.0
4814	Nov. 26	−0.2	B	1.0
4815	Nov. 26	+0.4	B	1.0
5572	1918 July 20	−0.7	A	0.5*
5588	Aug. 2	+0.1	A	0.8
5589	Aug. 2	+0.5	A	0.5*
5628	Aug. 14	0.0	A	0.7
5636	Aug. 19	−0.2	A	0.9
5899	Nov. 6	−0.5	F	0.8
5900	Nov. 6	+0.1	F	0.6
5990	Nov. 23	−0.2	D, H	0.8
5991	Nov. 23	+0.5	D, H	0.7

* One exposure.

Yale by Chase with the relative value + 0″.140 ± 0″.019. The absolute value from the spectrograph is 0″.120. Miss Darkow measured the McCormick plates, and found the relative parallax + 0″.101 ± 0″.012, with a proper motion in right ascension − 0″.477 where the corresponding value from Boss is − 0″.463.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−28.9	+14.9	+0.278
2	.09	− 8.5	−25.0	.261
3	.10	+18.2	−20.9	.234
4	.14	+19.2	+31.0	+0.227
Parallax star	0.12	− 1.6	− 0.2	

TABLE 2

REDUCTIONS FOR 54 PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3480	−0.0064	0.6	−0.814	−451	+0.0022	+0″.04
3517	− .0004	1.0	− .845	−446	− .0043	− .09
4330	− .0156	0.7	+ .572	−189	+ .0016	+ .03
4331	− .0162	0.7	+ .572	−189	+ .0022	+ .04
4380	− .0151	0.9	+ .469	−181	+ .0001	.00
4381	− .0130	1.0	+ .469	−181	− .0020	− .04
4814	− .0278	1.0	− .740	− 95	+ .0016	+ .03
4815	− .0296	1.0	− .740	− 95	+ .0034	+ .07
5572	− .0309	0.5	+ .887	+141	− .0023	− .03
5588	− .0346	0.8	+ .803	+154	+ .0002	.00
5589	− .0375	0.5	+ .803	+154	+ .0031	+ .05
5628	− .0362	0.7	+ .691	+166	+ .0005	+ .01
5636	− .0336	0.9	+ .636	+171	− .0027	− .05
5899	− .0484	0.8	− .513	+250	+ .0016	+ .03
5900	− .0471	0.6	− .513	+250	+ .0003	.00
5990	− .0466	0.8	− .709	+267	− .0022	− .04
5991	−0.0472	0.7	−0.709	+267	−0.0016	−0.03

The normal equations are:

$$13.2c - 2.238\mu - 0.3597\pi = -0.3652 \text{ mm.}$$
$$+ 73.2073\mu + 3.6306\pi = -0.3784 \text{ mm.}$$
$$+ 6.1351\pi = +0.0172 \text{ mm.}$$

from which:

$c = -0.02860$ mm.
$\mu = -0.00628$ mm. $= -0''.1307$, or $-0''.477$ per year.
$\pi = +0.00485$ mm. $= +\mathbf{0''.101 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00147 \text{ mm.} = \pm 0''.031.$$

LALANDE 1198 ($0^h\ 39^m$; $+1°\ 15'$)

This star of magnitude 8.14, of type Ko has a total proper motion of $0''.63$. With the Yale heliometer, Chase has found the relative parallax $+ 0''.069 \pm 0''.088$, and with the spectrograph, Adams found the absolute parallax $+ 0''.037$. Mr. Olivier measured the McCormick plates and found a relative parallax of $+ 0''.039 \pm 0''.008$, and a proper motion in right ascension $- 0''.058$ where the corresponding value by Porter is $- 0''.063$.

TABLE 1

PLATES OF LALANDE 1198

No.	Date.	Hour Angle.	Observers.	Weight.
3485	1916 Dec. 6	+0h1	M, Ol	1.0
3486	Dec. 6	+0.3	Ol	0.9
3547	1917 Jan. 1	−0.2	Ol	0.8
3548	Jan. 1	+0.2	Ol	0.8
3549	Jan. 1	+0.8	Ol	0.7
4255	Aug. 11	−0.1	B	0.7
4256	Aug. 11	+0.2	B	0.8
4318	Aug. 21	+0.1	Ol	0.9
4319	Aug. 21	+0.5	Ol	0.9
5614	1918 Aug. 6	0.0	A	0.9
5615	Aug. 6	+0.4	A	1.0
5637	Aug. 19	+0.4	A	0.9
5638	Aug. 19	+0.8	A	0.7*
6029	Nov. 30	+0.2	D	0.8
6030	Nov. 30	+0.6	C	0.5*
6084	Dec. 17	−0.4	H	1.0
6085	Dec. 17	+0.1	H	0.9
6126	Dec. 26	+0.6	F	0.7
7400	1919 July 30	+0.2	H	0.5*
7407	Aug. 2	−0.5	Ol	0.7
7408	Aug. 2	0.0	Ol	0.7
7510	Aug. 19	−0.5	F	0.9
7511	Aug. 19	−0.1	F	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−100.2	−12.4	+0.2779
2	.19	+ 16.0	−21.9	.3565
3	.12	+ 42.1	+ 6.0	.2346
4	.08	+ 42.1	+28.3	+0.1310
Parallax star	0.12	− 6.75	− 6.14	

TABLE 2

REDUCTIONS FOR LALANDE 1198

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3485	−0.0048	1.0	−0.811	−526	−0.0020	−0″.04
3486	− .0098	0.9	− .811	−526	+ .0030	+ .06
3547	− .0074	0.8	− .905	−500	+ .0003	.00
3548	− .0088	0.8	− .905	−500	+ .0017	+ .03
3549	− .0088	0.7	− .905	−500	+ .0017	+ .03
4255	− .0077	0.7	+ .736	−278	+ .0019	+ .03
4256	− .0036	0.8	+ .736	−278	− .0022	− .04
4318	− .0053	0.9	+ .629	−268	− .0007	− .01
4319	− .0043	0.9	+ .629	−268	− .0017	− .03
5614	− .0081	0.9	+ .783	+ 82	− .0003	− .01
5615	− .0072	1.0	+ .783	+ 82	− .0012	− .02
5637	− .0065	0.9	+ .654	+ 95	− .0022	− .04
5638	− .0108	0.7	+ .654	+ 95	+ .0021	+ .04
6029	− .0124	0.8	− .760	+198	+ .0002	.00
6030	− .0131	0.5	− .760	+198	+ .0010	+ .01
6084	− .0091	1.0	− .871	+215	− .0034	− .07
6085	− .0138	0.9	− .871	+215	+ .0013	+ .02
6126	− .0100	0.7	− .899	+224	− .0026	− .05
7400	− .0101	0.5	+ .840	+440	− .0009	− .01
7407	− .0124	0.7	+ .820	+443	+ .0013	+ .02
7408	− .0132	0.7	+ .820	+443	+ .0021	+ .04
7510	− .0108	0.9	+ .659	+460	− .0007	− .01
7511	−0.0150	0.9	+0.659	+460	+0.0035	+0.07

The normal equations are:

$$18.6c - 2.501\mu + 0.6299\pi = -0.1687 \text{ mm.}$$
$$+ 229.9454\mu + 20.0895\pi = -0.1142 \text{ mm.}$$
$$+ 11.3412\pi = 0.0000 \text{ mm.}$$

from which:

$c = -0.00924$ mm.

$\mu = -0.00076$ mm. $= -0''.0158$, or $-0''.058$ per year.

$\pi = +0.00186$ mm. $= +\mathbf{0''.039 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

η CASSIOPEIÆ ($0^h\ 43^m$; $+57°\ 17'$)

This star is well known to all users of small telescopes on account of it being an easy double and with a large difference of magnitude, the magnitudes being 3.6 and 7.6, and of types F8 and Ko respectively. The star has been very frequently measured both with small and with large telescopes. Since its measurement by Σ in the year 1832, it has completed only 90° of its orbit. As a consequence, there is a large range in the values of the periods published in Burnham's General Catalogue, a variation all the way from 181 to 500 years.

The star has a large proper motion of 1″.21, and its parallax has been frequently determined. The present series of plates was specially for the purpose of seeing how good an agreement there would be between the parallax values of the principal star and the companion. The results below show a difference of only 0″.002. In photographing this region, the rotating sector was used. When the opening in the sector was adjusted so that the companion was well visible and measurable on the photographic plates, the principal star was larger than one would wish in parallax work of the best quality. There remained always the possibility of further reducing the sector opening so as to make the principal star equal in size to the average comparison star. This would have made the companion too faint to be seen. On account of the exquisite definition of the 26-inch telescope, it was possible under good conditions of seeing and with perfect guiding to procure plates with both components measurable on the same plate. A reference to the plate numbers below in Tables 2 and 3 will readily show the frequency with which the plates were taken with the smaller sector opening. The diameter of the principal star below gives the value with the reduced sector. With sector opened to show the companion, the principal star had a diameter of 0.22 mm. The plates were measured by Mr. Mitchell.

TABLE 1

PLATES OF η CASSIOPEIÆ

No.	Date.	Hour Angle.	Observers.	Weight.
473	1914 Nov. 2	−0^{h}3	M	0.9
554	Nov. 11	0.0	G	0.8
585	Nov. 17	−0.2	M, A	0.8
660	Dec. 12	−0.3	A	0.5*
1605	1915 Sept. 6	−0.5	M	0.8
2065	Nov. 25	−0.3	A	0.9
2107	Dec. 4	−0.3	M	0.5*
2108	Dec. 4	0.0	M	0.5*
2845	1916 Aug. 4	−0.5	A	0.8
2846	Aug. 4	−0.1	A	0.8
2903	Aug. 19	−0.3	A	0.9
2942	Aug. 30	−0.5	A	0.9
2943	Aug. 30	−0.2	A	0.9
3498	Dec. 7	−0.5	L	1.0
3499	Dec. 7	−0.2	L	1.0
3511	Dec. 8	−0.6	L	1.0
3512	Dec. 8	−0.2	L	0.7*
4348	1917 Aug. 26	−0.5	A	1.0
4349	Aug. 26	−0.2	A	1.0
4357	Aug. 27	−1.1	Ol	1.0
4358	Aug. 27	−0.7	Ol	1.0
4364	Aug. 28	−0.8	B	1.0
4373	Aug. 29	−0.5	B	1.0
4374	Aug. 29	−0.1	B	1.0
4789	Nov. 18	−0.3	B	1.0
4790	Nov. 18	+0.1	B	1.0
4796	Nov. 19	−0.2	A	1.0
4840	Dec. 2	−0.4	M	0.8
4841	Dec. 2	0.0	M	0.8
4847	Dec. 5	−0.1	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−46.4	+35.8	+0.230
2	.08	−21.7	−25.5	.206
3	.11	+ 6.0	− 3.6	.196
4	.13	+18.1	−36.8	.184
5	.10	+44.0	+30.1	+0.184
Principal star	.10	− 2.2	+ 1.1	
Companion	0.05	− 2.5	+ 1.0	

TABLE 2

REDUCTIONS FOR η CASSIOPELÆ, PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
473	+0.0606	0.9	−0.426	−693	0.0000	0″.00
554	+ .0621	0.8	− .546	−684	− .0011	− .02
585	+ .0604	0.8	− .619	−678	+ .0009	+ .02
660	+ .0667	0.5	− .841	−663	− .0050	− .07
1605	+ .1144	0.8	+ .443	−385	+ .0013	+ .02
2065	+ .1174	0.9	− .702	−305	+ .0007	+ .01
2107	+ .1224	0.5	− .784	−296	− .0036	− .05
2108	+ .1211	0.5	− .784	−296	− .0023	− .03
2845	+ .1713	0.8	+ .804	− 52	− .0012	− .02
2846	+ .1698	0.8	+ .804	− 52	+ .0004	+ .01
2903	+ .1716	0.9	+ .660	− 37	− .0004	− .01
2942	+ .1708	0.9	+ .527	− 26	+ .0010	+ .02
2943	+ .1685	0.9	+ .527	− 26	+ .0033	+ .06
3498	+ .1712	1.0	− .812	+ 73	+ .0042	+ .09
3499	+ .1726	1.0	− .812	+ 73	+ .0028	+ .06
3511	+ .1752	1.0	− .819	+ 74	+ .0003	+ .01
3512	+ .1747	0.7	− .819	+ 74	+ .0008	+ .01
4348	+ .2295	1.0	+ .581	+335	− .0016	− .03
4349	+ .2278	1.0	+ .581	+335	+ .0001	.00
4357	+ .2292	1.0	+ .568	+336	− .0012	− .02
4358	+ .2284	1.0	+ .568	+336	− .0004	− .01
4789	+ .2316	1.0	− .633	+419	− .0012	− .02
4790	+ .2307	1.0	− .633	+419	− .0004	− .01
4796	+ .2304	1.0	− .645	+420	.0000	.00
4840	+ .2327	0.8	− .772	+433	− .0014	− .03
4841	+ .2335	0.8	− .772	+433	− .0022	− .04
4847	+0.2307	1.0	−0.795	+436	+0.0009	+0.02

The normal equations are:

$$23.3c + 9.140\mu - 4.6278\pi = + 4.0901 \text{ mm.}$$
$$317.8544\mu + 2.2036\pi = + 6.4862 \text{ mm.}$$
$$10.7857\pi = - 0.6649 \text{ mm.}$$

from which:

$c = +0.17121$ mm.

$\mu = +0.01542$ mm. $= +0''.3208$, or $+1''.171$ per year.

$\pi = +0.00866$ mm. $= +\mathbf{0''.180} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00120 \text{ mm.} = \pm 0''.0250.$$

TABLE 3

REDUCTIONS FOR η CASSIOPEIÆ, COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
554	−0.2405	0.8	−0.546	−684	+0.0005	+0″.01
585	− .2418	0.8	− .619	−678	+ .0020	+ .04
660	− .2402	0.5	− .841	−663	+ .0005	+ .01
1605	− .1917	0.8	+ .443	−385	− .0004	− .01
2065	− .1924	0.9	− .702	−305	+ .0010	+ .02
2107	− .1922	0.5	− .784	−296	+ .0012	+ .02
2108	− .1898	0.5	− .784	−296	− .0012	− .02
2845	− .1433	0.8	+ .804	− 52	− .0019	− .04
2846	− .1455	0.8	+ .804	− 52	+ .0003	.00
2903	− .1444	0.9	+ .660	− 37	− .0001	.00
2942	− .1441	0.9	+ .527	− 26	− .0001	.00
2943	− .1446	0.9	+ .527	− 26	+ .0004	+ .01
3498	− .1414	1.0	− .812	+ 73	− .0012	− .02
3499	− .1446	1.0	− .812	+ 73	+ .0020	+ .04
3511	− .1378	1.0	− .819	+ 74	− .0048	− .10
3512	− .1385	0.7	− .812	+ 74	− .0041	− .07
4364	− .0953	1.0	+ .555	+337	− .0009	− .02
4373	− .0976	1.0	+ .543	+338	+ .0014	+ .03
4374	− .0968	1.0	+ .543	+338	+ .0006	+ .01
4840	− .0964	1.0	− .772	+433	+ .0015	+ .03
4841	− .0980	1.0	− .772	+433	+ .0031	+ .06
4847	−0.0942	1.0	−0.795	+436	−0.0005	−0.01

The normal equations are:

$$18.8c + 1.239\mu - 3.2992\pi = -2.7433 \text{ mm.}$$
$$218.5608\mu + 4.0544\pi = +2.7303 \text{ mm.}$$
$$9.2208\pi = +0.6117 \text{ mm.}$$

from which:

$c = -0.14528$ mm.
$\mu = +0.01315$ mm. $= +0''.2737$, or $+0''.999$ per year.
$\pi = +0.00857$ mm. $= +\mathbf{0''.178 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00123 \text{ mm.} = \pm 0''.0256.$$

The parallax of the principal star is $+0''.180 \pm 0''.009$.
and that of the companion $+0''.178 \pm 0''.008$.
Hence, the parallax of the system is $+\mathbf{0''.179 \pm 0''.006}$.

Other values of the parallax are:

Parallax.	Authority.	Method.
$+0''.154 \pm 0''.045$	O. Struve	Equatorial
$+ .275 \pm .055$	Schweiger and Socoloff	Equatorial
$+ .180 \pm .015$	Peter	Heliometer
$+ .465 \pm .044$	Davis	Photography
$+ .34 \pm .044$	Flint	Meridian Circle
$+ .188 \pm .021$	Russell	Photography
$+ .096 \pm .067$	Jewdokimov	Meridian Circle
$+ .182 \pm 0.009$	Steele	Photography
$+0.173 \pm .006$	Allegheny	Photography

The present measures give the first trigonometric determination of the parallax of the fainter star. The spectroscopic method of Adams furnishes the values for principal star and component, $+0''.166$ and $+0''.166$ respectively.

In spite of the fact that the orbital motion is very slow, nevertheless, it makes itself manifest in the above measures. Boss in the Preliminary General Catalogue finds the proper motion of the center of gravity of the system along a great circle, or $\mu\alpha \cos \delta = \mp 1''.127$. The amounts that the proper motions of the two components of η Cassiopeiæ differ from this furnish a measure of the orbital motion, and consequently, present a ready means of determining the relative masses. It is easy to find that the ratio of the masses B/A is 0.34, where A is the principal star, and B the companion.

The first determination of this ratio was found in 1881 by L. Struve (*Melanges Math. et Astr.*, Vol. V) who gave a value $B/A = 0.268$. A later discussion by T. Lewis (*Mem. R. A. S.*, Vol. LVI) gives $B/A = 0.5$. The Preliminary General Catalogue of Boss (p. 264) furnishes the values:

From right ascensions, $B/A = 1.63$ (Weight 60).
From declinations $= 0.41$ (Weight 85).

Boss assumes the value of $B/A = 0.76$, but adds that this result is "uncertain owing to the interdependence of the expressions for orbital and proper motions respectively."

In *Astronomical Journal*, **29**, 173, 1916, Van Biesbroeck gives the best values so far obtained. From the measures of two photographs taken with the 40-inch telescope, and separated by an interval of eleven years, there results from measures in right ascension, the value $B/A = 0.23$, and from declination measures, the value $B/A = 0.31$, with a mean value of 0.27.

The McCormick photographs cover a period of three years. The agreement between the photographic values at Yerkes and at McCormick, and the wide disagreement between the two values due to Boss show the advantages of photography for investigations of this kind.

LALANDE 1799 ($0^h\ 57^m$; $+4°\ 31'$)

This star of 8.4 magnitude, of K2 type, and of total proper motion $0''.48$ has been found by Chase to have a relative parallax of $+ 0''.046 \pm 0''.056$ and by Mt. Wilson to have a spectroscopic parallax $+ 0''.046$. Miss Hawes measured the McCormick plates and found the relative parallax of $+ 0''.022 \pm 0''.007$, with a proper motion in right ascension amounting to $+ 0''.268$ per year. The value of the proper motion in right ascension given by Porter is $+ 0''.354$, but his results seem to show that there is a considerable error in the position given by Lalande.

TABLE 1

PLATES OF LALANDE 1799

No.	Date.	Hour Angle.	Observers.	Weight.
4340	1917 Aug. 25	+0h1	Ol	1.0
4341	Aug. 25	+0.5	Ol	1.0
4366	Aug. 28	+0.2	B	0.8
4367	Aug. 28	+0.7	B	0.9
4885	Dec. 20	−0.2	B	1.0
4886	Dec. 20	+0.2	B	1.0
5652	1918 Aug. 23	−0.4	A	0.8
5653	Aug. 23	+0.1	A	1.0
5663	Aug. 29	−0.2	A	0.7*
5879	Nov. 5	−0.1	H	0.9
5880	Nov. 5	+0.4	D	1.0
5908	Nov. 7	−0.5	H	1.0
5909	Nov. 7	+0.1	D	1.0
6076	Dec. 6	+0.9	H	1.0
7362	1919 July 26	−1.0	H	0.9
7363	July 26	−0.6	H	0.7*
7378	July 27	−0.7	D	1.0
7379	July 27	−0.3	D	1.0
7398	July 30	−0.9	H	1.0
7399	July 30	−0.5	H	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−40.0	+19.9	+0.373
2	.10	−32.1	−47.9	.161
3	.12	+20.9	+ 6.0	.234
4	.14	+51.2	+22.0	0.232
Parallax star	0.14	− 3.34	+ 6.20	

TABLE 2

REDUCTIONS FOR LALANDE 1799

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
4340	−0.0350	1.0	+0.639	−388	−0.0006	−0″.01
4341	− .0370	1.0	+ .639	−388	+ .0014	+ .03
4366	− .0352	0.8	+ .604	−385	− .0003	− .01
4367	− .0347	0.9	+ .604	−385	− .0008	− .02
4885	− .0326	1.0	− .867	−271	− .0004	− .01
4886	− .0350	1.0	− .867	−271	+ .0020	+ .04
5652	− .0214	0.8	+ .665	− 25	− .0013	− .03
5653	− .0228	1.0	+ .665	− 25	+ .0001	.00
5663	− .0215	0.7	+ .595	− 19	− .0011	− .02
5879	− .0227	0.9	− .417	+ 49	+ .0014	+ .03
5880	− .0197	1.0	− .417	+ 49	− .0016	− .03
5908	− .0210	1.0	− .445	+ 51	− .0002	.00
5909	− .0219	1.0	− .445	+ 51	+ .0007	+ .01
6076	− .0190	1.0	− .774	+ 80	− .0015	− .03
7362	− .0098	0.9	+ .894	+312	− .0008	− .02
7363	− .0126	0.7	+ .894	+312	+ .0020	+ .04
7378	− .0119	1.0	+ .889	+313	+ .0013	+ .03
7379	− .0130	1.0	+ .889	+313	+ .0024	+ .05
7398	− .0092	1.0	+ .873	+316	− .0013	− .03
7399	−0.0088	1.0	+0.873	+316	−0.0017	−0.04

The normal equations are:

$$18.7c + 0.015\mu + 4.6824\pi = -0.4165 \text{ mm.}$$
$$+ 126.8894\mu + 9.4930\pi = +0.4575 \text{ mm.}$$
$$+ 9.6932\pi = -0.0619 \text{ mm.}$$

from which:

$c = -0.02254$ mm.

$\mu = +0.00353$ mm. $= +0''.0734$, or $+0''.268$ per year.

$\pi = +0.00105$ mm. $= +$ **0″.022 ± 0″.007.**

Probable error of plate of unit weight

$$= 0.00092 \text{ mm.} = \pm 0''.019.$$

ϵ PISCIUM (0^h 57^m; $+7°$ $27'$)

This star is of G5 type, of magnitude 4.45, and of comparatively small proper motion, 0″.08, so that a small value of the parallax would be expected. The value below agrees closely with that obtained at Allegheny Observatory by photography, + 0″.023 ± 0″.008. (*Publ. Allegheny Observatory*, **4**, 1, 1917.) By the spectrographic method, Adams derives the absolute parallax + 0″.014. The McCormick value of the proper motion in right ascension is − 0″.066, while that due to Boss is − 0″.080. Twenty-one plates were measured by Mr. Alden.

TABLE 1

PLATES OF ϵ PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
2114	1915 Dec. 6	−0^h.4	G	1.0
2115	Dec. 6	0.0	G	0.9
2282	1916 Jan. 4	−0.5	Ol	0.7
2922	Aug. 25	+0.3	A	0.9
2923	Aug. 25	+0.6	A	1.0
2929	Aug. 26	−0.3	Ol	0.6
2930	Aug. 26	0.0	Ol	0.7
2944	Aug. 30	0.0	A	0.8
2945	Aug. 30	+0.3	A	0.9
3464	Dec. 1	−0.1	Ol	1.0
3543	Dec. 31	−0.1	A	1.0
3544	Dec. 31	+0.2	A	1.0
4249	1917 Aug. 5	−0.4	A	0.9
4250	Aug. 5	0.0	A	1.0
4257	Aug. 11	+0.6	B	0.9
4269	Aug. 13	−0.9	A	1.0
4270	Aug. 13	−0.5	A	1.0
4816	Nov. 26	−0.2	B	1.0
4817	Nov. 26	+0.2	B	1.0
4823	Nov. 28	−0.1	A	1.0
4824	Nov. 28	+0.3	A	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
.1	0.27	−39.5	+ 9.9	+0.2903
2	.11	−20.0	− 9.7	.2649
3	.10	+26.7	−40.8	.2100
4	.09	+32.8	+40.6	+0.2348
Parallax star	0.14	− 3.46	+ 1.27	

TABLE 2

REDUCTIONS FOR ϵ PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
2114	−0.0084	1.0	−0.770	−415	−0.0001	0″.00
2115	− .0052	0.9	− .770	−415	− .0033	− .06
2282	− .0100	0.7	− .906	−386	+ .0011	+ .02
2922	− .0066	0.9	+ .638	−152	− .0027	− .05
2923	− .0084	1.0	+ .638	−152	− .0009	− .02
2929	− .0111	0.6	+ .627	−151	+ .0018	+ .03
2930	− .0100	0.7	+ .627	−151	+ .0007	+ .01
2944	− .0138	0.8	+ .578	−147	+ .0044	+ .08
2945	− .0132	0.9	+ .578	−147	+ .0038	+ .07
3464	− .0118	1.0	− .732	− 54	+ .0002	.00
3543	− .0109	1.0	− .902	− 24	− .0011	− .02
3544	− .0122	1.0	− .902	− 24	+ .0002	.00
4249	− .0106	0.9	+ .831	+193	− .0015	− .03
4250	− .0124	1.0	+ .831	+193	+ .0003	+ .01
4257	− .0122	0.9	+ .783	+199	.0000	.00
4269	− .0104	1.0	+ .766	+201	− .0018	− .04
4270	− .0106	1.0	+ .766	+201	− .0016	− .03
4816	− .0161	1.0	− .680	+303	+ .0014	+ .03
4817	− .0152	1.0	− .680	+303	+ .0006	+ .01
4823	− .0155	1.0	− .701	+308	+ .0008	+ .02
4824	−0.0143	1.0	−0.701	+308	−0.0004	−0.01

The normal equations are:

$$19.3c + 2.741\mu - 0.5697\pi = -0.2209 \text{ mm.}$$
$$+ 110.6429\mu + 3.9199\pi = -0.1237 \text{ mm.}$$
$$+ 10.6615\pi = +0.0142 \text{ mm.}$$

from which:

$c = -0.01129$ mm.
$\mu = -0.00088$ mm. $= -0''.0182$, or $-0''.066$ per year.
$\pi = +0.00105$ mm. $= +0''.022 \pm 0''.008$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

β ANDROMEDÆ ($1^h\ 4^m$; $+35°\ 5'$)

Three trigonometric values of the parallax of this star have been found: Pritchard by photography, $+0''.073 \pm 0''.023$, Flint by meridian circle, $+0''.036 \pm 0''.031$, and Allegheny Observatory by photography, $+0''.033 \pm 0''.007$. The star is of Ma type, and of magnitude 2.37. The total proper motion is $0''.22$, that in right ascension, as determined by Boss, is $+0''.181$ per year. Adams finds the spectroscopic parallax of $+0''.048$. The series of seventeen plates were measured by Mr. Olivier.

TABLE 1

PLATES OF β ANDROMEDÆ

No.	Date.	Hour Angle.	Observers.	Weight.
686	1914 Dec. 17	-0^h1	G	0.5*
705	Dec. 23	−0.5	A	0.5
743	1915 Jan. 7	−0.2	Ol	0.8
763	Jan. 9	−0.1	M	0.8
775	Jan. 10	−0.1	M	0.9
1540	Aug. 9	−0.5	Ol	0.8
1541	Aug. 9	0.0	Ol	0.5*
1557	Aug. 15	−0.3	Ol	0.7
1561	Aug. 18	−0.7	Ol	0.5
1562	Aug. 18	−0.4	Ol	0.8
1594	Aug. 31	−1.2	Ol	0.9
1595	Aug. 31	−0.6	Ol	0.7
2147	Dec. 10	−0.8	Ol, G	0.8
2148	Dec. 10	−0.3	G	0.6*
2196	Dec. 22	−0.8	Ol	0.7
2197	Dec. 22	−0.3	G	0.7
2264	1916 Jan. 3	−0.3	Ol	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−35.3	−26.0	+0.201
2	.21	−29.7	+21.6	.278
3	.12	+10.4	+16.1	.278
4	.12	+54.6	−11.7	+0.243
Parallax star	0.24	+ 0.8	+ 2.4	

TABLE 2

REDUCTIONS FOR β ANDROMEDÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
686	−0.0044	0.5	−0.840	−221	−0.0016	−0″.02
705	− .0053	0.5	− .872	−205	− .0002	.00
743	− .0075	0.8	− .909	−190	+ .0024	+ .04
763	− .0046	0.8	− .909	−188	− .0005	− .01
775	− .0044	0.9	− .908	−187	− .0006	− .01
1540	+ .0079	0.8	+ .820	+ 24	− .0012	− .02
1541	+ .0075	0.5	+ .820	+ 24	− .0008	− .01
1557	+ .0083	0.7	+ .770	+ 30	− .0015	− .03
1561	+ .0083	0.5	+ .741	+ 33	− .0015	− .02
1562	+ .0042	0.8	+ .741	+ 33	+ .0026	+ .05
1594	+ .0050	0.9	+ .599	+ 36	+ .0015	+ .03
1595	+ .0065	0.7	+ .599	+ 36	.0000	.00
2147	+ .0076	0.8	− .789	+147	− .0014	− .02
2148	+ .0044	0.6	− .789	+147	+ .0018	+ .03
2196	+ .0095	0.7	− .866	+159	− .0031	− .05
2197	+ .0035	0.7	− .866	+159	+ .0029	+ .05
2264	+0.0068	1.0	−0.905	+171	−0.0001	0.00

The normal equations are:

$$12.2c + 0.684\mu - 2.8229\pi = + 0.0386 \text{ mm.}$$
$$+ 23.3815\mu + 2.0804\pi = + 0.0848 \text{ mm.}$$
$$+ 8.1146\pi = + 0.0194 \text{ mm.}$$

from which:

$c = + 0.00363$ mm.

$\mu = + 0.00327$ mm. $= + 0''.0680$, or $+ 0''.248$ per year.

$\pi = + 0.00281$ mm. $= + \mathbf{0''.058} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00100 \text{ mm.} = \pm 0''.121.$$

θ CASSIOPEIÆ ($1^h\ 5^m$; $+54°\ 37'$)

The present results give the second determination of the parallax of θ Cassiopeiæ under the auspices of Columbia University. In 1893, Professor Harold Jacoby, from a discussion of Rutherfurd photographs found a parallax of $+ 0''.232 \pm 0''.067$. Two later values have been found: $- 0''.018 \pm 0''.091$ with the meridian circle by Jewdokimov, and $- 0''.003 \pm 0''.003$ by photography at Swarthmore. The star is of A5 type, and of magnitude 4.52, with a proper motion in right ascension, as determined by Boss, of $+ 0''.229$ per year. Nineteen plates were measured by Mr. Alden.

TABLE 1

PLATES OF θ CASSIOPEIÆ

No.	Date.	Hour Angle.	Observers.	Weight.
496	1914 Nov. 4	-0^h1	G	0.9
514	Nov. 5	−0.2	M	0.6*
566	Nov. 12	−0.1	Ol	1.0
628	Nov. 23	−0.1	G, Ol	0.9
644	Nov. 25	0.0	M, A	1.0
1606	1915 Sept. 6	−0.3	M	0.8
1626	Sept. 8	−0.2	M	1.1†
2020	Nov. 16	−0.4	A	1.0
2246	1916 Jan. 2	−0.7	M	0.9
2247	Jan. 2	−0.3	M	1.0
2838	July 29	−0.6	A	1.0
2839	July 29	−0.3	A	0.7*
2858	Aug. 7	−0.1	A	0.7*
2870	Aug. 13	−0.3	Ol	0.7
2871	Aug. 13	0.0	Ol	0.6*
2885	Aug. 17	0.0	Ol	0.6*
3554	1917 Jan. 3	−0.5	M	1.0
3555	Jan. 3	−0.2	M	0.9
3560	Jan. 6	−0.4	M	1.0

* One exposure. † Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−44.1	−28.3	+0.1944
2	.13	−16.3	+21.5	.1639
3	.12	−13.9	−12.7	.2023
4	.16	+28.9	−27.1	.2523
5	.16	+45.4	+46.6	+0.1871
Parallax star	0.17	+ 1.7	− 2.7	

TABLE 2

REDUCTIONS FOR θ CASSIOPELÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
496	−0.0134	0.9	−0.371	−427	+0.0003	+0″.01
514	− .0107	0.6	− .386	−426	− .0024	− .04
566	− .0178	1.0	− .484	−419	+ .0046	+ .10
628	− .0078	0.9	− .622	−408	− .0054	− .11
644	− .0156	1.0	− .645	−406	+ .0024	+ .05
1606	− .0009	0.8	+ .526	−121	− .0030	− .06
1626	− .0059	1.1	+ .500	−119	+ .0020	+ .04
2020	− .0032	1.0	− .533	− 50	− .0014	− .03
2246	− .0040	0.9	− .903	− 3	− .0004	− .01
2247	− .0044	1.0	− .903	− 3	.0000	.00
2838	+ .0059	1.0	+ .888	+206	− .0013	− .03
2839	+ .0033	0.7	+ .888	+206	+ .0013	+ .02
2858	+ .0068	0.7	+ .831	+215	− .0021	− .04
2870	+ .0054	0.7	+ .783	+221	− .0007	− .01
2871	− .0008	0.6	+ .783	+221	+ .0055	+ .09
2885	+ .0060	0.6	+ .746	+225	− .0013	− .02
3554	+ .0068	1.0	− .906	+364	− .0026	− .05
3555	+ .0012	0.9	− .906	+364	+ .0030	+ .06
3560	+0.0038	1.0	−0.908	+367	+0.0005	+0.01

The normal equations are:

$$16.4c - 1.339\mu - 2.6048\pi = - 0.0458 \text{ mm.}$$
$$+ 137.7802\mu + 6.5162\pi = + 0.3410 \text{ mm.}$$
$$+ 8.8804\pi = + 0.0412 \text{ mm.}$$

from which:

$c = - 0.00224$ mm.
$\mu = + 0.00235$ mm. $= + 0''.0488$, or $+ 0''.178$ per year.
$\pi = + 0.00226$ mm. $= + \mathbf{0''.047 \pm 0''.013}$.

Probable error of plate of unit weight

$$\pm 0.00178 \text{ mm.} = \pm 0''.037.$$

ω ANDROMEDÆ (1^h 22^m; $+44°$ 53′)

This is a double star, β 999, with a 12th magnitude companion at a distance $2''.5$. The principal star is of 4.96 magnitude, and of type F5, and the system has a considerable proper motion of $0''.35$. The proper motion in right ascension determined by Boss is $+ 0''.344$. Two measured values of the parallax have been published, both from observations with meridian circle: $+ 0''.08 \pm 0''.042$ by Flint, and $+ 0''.097 \pm 0''.087$ by Jewdokimov. By the spectroscopic method, Adams finds the parallax $+ 0''.030$. By photography the recent value at Yerkes is $+ 0''.001 \pm 0''.016$. The plates of this series were measured by Mr. Alden.

TABLE 1

PLATES OF ω ANDROMEDÆ

No.	Date.	Hour Angle.	Observers.	Weight.
661	1914 Dec. 12	0^h0	M, A	1.0
706	Dec. 23	−0.2	A	0.8
709	Dec. 26	−0.4	G	1.0
719	Dec. 27	−0.1	A	1.0
732	1915 Jan. 2	−0.2	A	0.7*
1535	Aug. 6	0.0	G	0.6*
1573	Aug. 23	−1.1	A	1.0
1574	Aug. 23	−0.7	A	1.0
1583	Aug. 25	−1.2	A	0.8
1584	Aug. 25	−0.8	A	1.0
2066	Nov. 25	−0.4	A	1.0
2067	Nov. 25	0.0	A	0.8
2133	Dec. 9	−1.0	A	0.8
2134	Dec. 9	−0.6	A, M	0.9
2179	Dec. 19	−0.6	M	1.0
2180	Dec. 19	−0.2	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−44.0	−38.2	+0.2437
2	.25	−22.6	+45.2	.2355
3	.21	+33.9	+38.3	.2533
4	.20	+32.7	−45.3	+0.2675
Parallax star	0.18	+ 1.3	− 1.1	

TABLE 2

REDUCTIONS FOR ω ANDROMEDÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
661	+0.0028	1.0	−0.774	−218	−0.0023	−0″.05
706	− .0028	0.8	− .853	−207	+ .0037	+ .07
709	− .0007	1.0	− .869	−204	+ .0018	+ .04
719	+ .0032	1.0	− .874	−203	− .0021	− .04
732	+ .0019	0.7	− .896	−197	− .0005	− .01
1535	+ .0131	0.6	+ .875	+ 19	+ .0009	+ .01
1573	+ .0146	1.0	+ .741	+ 36	.0000	.00
1574	+ .0146	1.0	+ .741	+ 36	.0000	.00
1583	+ .0155	0.8	+ .721	+ 38	− .0008	− .01
1584	+ .0146	1.0	+ .721	+ 38	+ .0001	.00
2066	+ .0184	1.0	− .595	+130	− .0007	− .01
2067	+ .0158	0.8	− .595	+130	+ .0019	+ .02
2133	+ .0229	0.8	− .745	+144	− .0046	− .08
2134	+ .0178	0.9	− .745	+144	+ .0005	+ .01
2179	+ .0170	1.0	− .826	+154	+ .0017	+ .02
2180	+0.0180	1.0	−0.826	+154	+0.0007	+0.01

The normal equations are:

$$14.4c + 0.101\mu - 4.5113\pi = + 0.1688 \text{ mm.}$$
$$+ 31.0306\mu + 3.2487\pi = + 0.1568 \text{ mm.}$$
$$+ 8.7008\pi = - 0.0286 \text{ mm.}$$

from which:

$c = + 0.01204$ mm.

$\mu = + 0.00490$ mm. $= + 0''.1018$, or $+ 0''.372$ per year.

$\pi = + 0.00113$ mm. $= + \mathbf{0''.023 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00131 \text{ mm.} = \pm 0''.027.$$

η PISCIUM ($1^h\ 26^m$; $+14°\ 49'$)

By photography Allegheny Observatory derives the relative parallax $- 0''.015 \pm 0''.005$, while Adams furnishes the spectro-

scopic value of + 0″.015. The star is of G5 type, of magnitude 3.72, and of small proper motion 0″.03, that in right ascension, according to Boss, amounting to + 0″.029 per year. Mr. Olivier measured the series of plates.

TABLE 1

PLATES OF η PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
181	1914 Aug. 16	−0h.2	Ol	0.8
182	Aug. 16	+0.4	Ol	0.5*
515	Nov. 5	+0.1	M	1.0
555	Nov. 11	0.0	G	0.9
567	Nov. 12	+0.3	Ol	0.8
568	Nov. 12	+0.8	Ol	1.0
578	Nov. 13	−0.6	G	0.9
708	Dec. 26	−1.0	G	1.0
734	1915 Jan. 4	−0.3	Ol	0.5
1546	Aug. 12	−0.2	G	0.8
1547	Aug. 12	+0.2	Ol	0.7
1558	Aug. 15	+0.1	G	0.7
1563	Aug. 18	−0.1	Ol	0.9
1564	Aug. 18	+0.3	Ol	0.9
2089	Nov. 27	−0.2	G	0.7
2199	Dec. 22	+0.5	Ol	0.7
2236	Dec. 27	−0.2	Ol	0.5*
2237	Dec. 27	+0.4	G	1.0
2316	1916 Jan. 14	+0.2	Ol	0.5*
2317	Jan. 14	+0.6	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	−26.8	+45.8	+0.233
2	.19	− 0.1	−52.7	.238
3	.24	+12.2	−42.6	.253
4	.28	+14.7	+49.5	+0.276
Parallax star	0.28	+ 0.9	+ 1.0	

TABLE 2

REDUCTIONS FOR η PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
181	+0.0124	0.8	+0.814	−286	+0.0026	+0″.05
182	+ .0154	0.5	+ .814	−286	− .0004	− .01
515	+ .0125	1.0	− .306	−205	− .0002	− .00
555	+ .0167	0.9	− .395	−199	− .0046	− .09
567	+ .0113	0.8	− .410	−198	+ .0008	+ .01
568	+ .0124	1.0	− .410	−198	− .0003	− .01
578	+ .0089	0.9	− .423	−197	+ .0032	+ .06
708	+ .0108	1.0	− .863	−154	+ .0002	.00
734	+ .0128	0.5	− .879	−145	− .0019	− .03
1546	+ .0135	0.8	+ .846	+ 75	+ .0007	+ .01
1547	+ .0132	0.7	+ .846	+ 75	+ .0010	+ .02
1558	+ .0158	0.7	+ .824	+ 78	− .0017	− .03
1563	+ .0168	0.9	+ .799	+ 79	− .0027	− .05
1564	+ .0135	0.9	+ .799	+ 79	+ .0006	+ .01
2089	+ .0084	0.7	− .605	+182	+ .0023	+ .04
2199	+ .0084	0.7	− .839	+207	+ .0017	+ .03
2236	+ .0138	0.5	− .868	+212	− .0038	− .05
2237	+ .0092	1.0	− .868	+212	+ .0008	+ .02
2316	+ .0143	0.5	− .914	+230	− .0044	− .06
2317	+0.0074	0.9	−0.914	+230	+0.0025	+0.05

The normal equations are:

$$15.7c - 2.945\mu - 2.3329\pi = + 0.1918 \text{ mm.}$$
$$+ 54.2312\mu - 2.6662\pi = - 0.0561 \text{ mm.}$$
$$+ 8.4368\pi = - 0.0098 \text{ mm.}$$

from which:

$c = + 0.01250$ mm.

$\mu = - 0.00024$ mm. $= - 0''.0051$, or $- 0''.019$ per year.

$\pi = + 0.00243$ mm. $= + \mathbf{0''.046 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00142 \text{ mm.} = \pm 0''.029.$$

ν ANDROMEDÆ ($1^h\ 31^m$; $+40°\ 54'$)

The only value of the parallax of this star so far published is the spectroscopic result of Adams of $+\ 0''.091$. The star is of G type, of magnitude 4.18, and of fairly large proper motion of $0''.42$, of which, according to Boss $-\ 0''.179$ is in right ascension. Of the seventeen plates of the series, eleven were measured by Mr. Graham and the balance by Mr. Mitchell.

TABLE 1

PLATES OF υ ANDROMEDÆ

No.	Date.	Hour Angle.	Observers.	Weight.
779	1915 Jan. 13	$-0^h.1$	M	0.8
790	Jan. 14	−0.2	Ol	0.8
806	Jan. 16	−0.1	M	0.5
1644	Sept. 10	−1.2	Ol	0.8
1645	Sept. 10	−0.8	Ol	0.8
1658	Sept. 11	−0.5	M	0.8
1659	Sept. 11	−0.1	M	0.9
1666	Sept. 12	−0.4	Ol	1.0
2049	Nov. 19	−0.4	G	1.0
2185	Dec. 21	−0.5	G	0.7
2248	1916 Jan. 2	−0.2	M	0.8
2970	Sept. 5	−0.5	M	0.5*
3005	Sept. 16	−0.7	M	1.0
3006	Sept. 16	−0.3	M	1.0
3034	Sept. 19	−0.2	A	0.8
3561	1917 Jan. 6	−0.4	M	1.0
3562	Jan. 6	−0.1	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−39.7	+19.1	+0.211
2	.15	−40.6	−14.0	.230
3	.10	+33.8	+38.4	.251
4	.21	+46.5	−43.5	+0.308
Parallax star	0.14	+ 5.1	− 3.0	

TABLE 2

REDUCTIONS FOR v ANDROMEDÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
779	+0.0480	0.8	−0.915	−339	−0.0025	−0″.05
790	+ .0524	0.8	− .915	−338	+ .0019	+ .04
806	+ .0503	0.5	− .915	−336	− .0001	.00
1644	+ .0513	0.8	+ .569	− 99	+ .0031	+ .06
1645	+ .0481	0.8	+ .569	− 99	− .0001	.00
1658	+ .0472	0.8	+ .556	− 98	− .0010	− .02
1659	+ .0486	0.9	+ .556	− 98	+ .0004	+ .01
1666	+ .0478	1.0	+ .543	− 97	− .0003	− .01
2049	+ .0444	1.0	− .485	− 29	+ .0006	+ .01
2185	+ .0402	0.7	− .824	+ 3	− .0019	− .03
2248	+ .0417	0.8	− .889	+ 15	.0000	.00
2970	+ .0413	0.5	+ .621	+262	+ .0020	+ .03
3005	+ .0368	1.0	+ .479	+273	− .0018	− .04
3006	+ .0384	1.0	+ .479	+273	− .0002	.00
3034	+ .0371	0.8	+ .437	+276	− .0014	− .02
3561	+ .0340	1.0	− .902	+385	+ .0016	+ .03
3562	+0.0323	1.0	−0.902	+385	−0.0001	0.00

The normal equations are:

$$14.2c + 5.213\mu - 1.4818\pi = + 0.6120 \text{ mm.}$$
$$+ 82.2996\mu + 1.6036\pi = + 0.0282 \text{ mm.}$$
$$+ 6.8710\pi = - 0.0524 \text{ mm.}$$

from which:

$c = + 0.04429$ mm.

$\mu = - 0.00251$ mm. $= - 0''.0522$, or $- 0''.190$ per year.

$\pi = + 0.00252$ mm. $= + \mathbf{0''.052 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00098 \text{ mm.} = \pm 0''.020.$$

41 H ANDROMEDÆ (1^h 35^m; $+42°$ 6′)

This star of magnitude 4.97, and of type F has a considerable proper motion of 0″.82 per year. Its parallax has been twice determined with the following results: Smith with the Yale

TABLE 1

PLATES OF 41 H ANDROMEDÆ

No.	Date.	Hour Angle.	Observers.	Weight.
2265	1916 Jan. 3	−0^h.2	Ol	0.7
2859	Aug. 7	−0.2	A	1.0
2904	Aug. 19	−0.8	A	0.7
2905	Aug. 19	−0.5	A	1.0
2994	Sept. 11	−1.2	Ol	1.0
2995	Sept. 11	−0.9	Ol	1.0
3583	1917 Jan. 16	−0.1	M	1.0
3594	Jan. 19	0.0	Ol	0.5*
4271	Aug. 13	−0.6	A	1.0
4272	Aug. 13	−0.2	A	1.0
4284	Aug. 18	−1.1	Ol	1.0
4285	Aug. 18	−0.8	Ol	0.9
4848	Dec. 5	−0.5	A	1.0
4895	Dec. 22	−0.4	B	1.0
4896	Dec. 22	−0.1	B	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−49.3	+21.9	+0.1710
2	.08	−21.4	+11.9	.1689
3	.12	−18.1	−45.2	.1604
4	.08	− 9.3	+40.9	.1728
5	.10	+38.7	+ 9.8	.1674
6	.07	+59.4	−39.3	+0.1595
Parallax star	0.17	− 0.6	+ 1.0	

heliometer obtained the value + 0″.103 ± 0″.037; and Jewdokimov with the meridian circle secured the result + 0″.166 ± 0″.094. Adams obtains the absolute parallax + 0″.095 by the spectroscopic method. Mr. Alden measured the present series of plates and obtained for the proper motion the value in right ascension of + 0″.854, while Boss derived the value + 0″.807.

TABLE 2

REDUCTIONS FOR 41 H ANDROMEDÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2265	−0.0298	0.7	−0.890	−429	−0.0023	−0″.04
2859	+ .0009	1.0	+ .891	−212	− .0007	− .01
2904	− .0020	0.7	+ .809	−200	+ .0032	+ .06
2905	+ .0031	1.0	+ .809	−200	− .0019	− .04
2994	− .0022	1.0	+ .564	−177	+ .0049	+ .10
2995	+ .0041	1.0	+ .564	−177	− .0014	− .03
3583	+ .0115	1.0	− .917	− 50	− .0011	− .02
3594	+ .0085	0.5	− .916	− 47	+ .0023	+ .03
4271	+ .0410	1.0	+ .856	+159	+ .0008	+ .02
4272	+ .0442	1.0	+ .856	+159	− .0024	− .05
4284	+ .0440	1.0	+ .820	+164	− .0018	− .04
4285	+ .0412	0.9	+ .820	+164	+ .0010	+ .02
4848	+ .0484	1.0	− .674	+273	− .0006	− .01
4895	+ .0451	1.0	− .827	+290	+ .0040	+ .08
4896	+0.0518	0.9	−0.827	+290	−0.0027	−0.05

The normal equations are:

$$13.7c + 1.738\mu + 2.4210\pi = + 0.3058 \text{ mm.}$$
$$+ 64.4019\mu - 4.4092\pi = + 0.7396 \text{ mm.}$$
$$+ 8.8544\pi = + 0.0383 \text{ mm.}$$

from which:

$c = + 0.02011$ mm.

$\mu = + 0.01126$ mm. $= + 0″.2339$, or $+ 0″.854$ per year.

$\pi = + 0.00443$ mm. $= +$ **0″.092 ± 0″.013.**

Probable error of plate of unit weight

$$\pm 0.00172 \text{ mm.} = \pm 0″.036.$$

τ CETI ($1^h\ 39^m$; $-16°\ 27'$)

This star is of more than usual interest due to the fact that it is one of the ten nearest stars to the solar system. It has a parallax less than that of Sirius, but slightly greater than 61 Cygni. Two trigonometric parallaxes have been found: $+\ 0''.310 \pm 0''.012$ with the heliometer by de Sitter, and $+\ 0''.268 \pm 0''.029$ with the meridian circle by Flint. Adams gives the spectroscopic value of $+\ 0''.257$. The star is of K type, of magnitude 3.65, and with a total proper motion of $1''.92$. The proper motion in right ascension determined by Boss is $-\ 1''.717$ per year, while that from the McCormick photographs is $-\ 1''.711$. The seventeen plates of the series were measured by Mr. Mitchell.

TABLE 1

PLATES OF τ CETI

No.	Date.	Hour Angle.	Observers.	Weight.
720	1914 Dec. 27	$+0^h.7$	A	0.6
764	1915 Jan. 9	0.0	M	0.4*
1685	Sept. 14	−0.5	A	0.6
1707	Sept. 16	+0.1	Ol	1.0
2050	Nov. 23	+0.1	G	0.5
2109	Dec. 4	−0.3	M	0.9
2110	Dec. 4	+0.2	A	0.9
2181	Dec. 19	+0.3	M	0.7
2957	1916 Sept. 3	+0.1	A	0.8
2958	Sept. 3	+0.6	A	0.7
3007	Sept. 16	+0.4	M	0.6
3015	Sept. 17	−0.3	A	0.8
3033	Sept. 19	−0.9	M, A	0.9
3500	Dec. 7	−0.5	L	0.7
3501	Dec. 7	0.0	L	0.7
3550	1917 Jan. 2	+0.2	L	1.0
3563	Jan. 6	+0.4	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−67.3	+38.2	+0.211
2	.10	−15.9	+41.7	.229
3	.12	+15.8	−14.6	.193
4	.08	+15.8	−50.4	.164
5	.10	+51.6	−14.9	+0.203
Parallax star	0.16	− 1.7	+ 3.4	

TABLE 2

REDUCTIONS FOR τ CETI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
720	+0.0778	0.6	−0.853	−406	−0.0045	−0″.07
764	+ .0667	0.4	− .908	−393	+ .0028	+ .04
1685	+ .0414	0.6	+ .547	−145	− .0060	− .10
1707	+ .0334	1.0	+ .520	−143	+ .0012	+ .02
2050	+ .0040	0.5	− .511	− 75	− .0002	.00
2109	− .0017	0.9	− .648	− 64	+ .0010	+ .02
2110	− .0036	0.9	− .648	− 64	+ .0028	+ .06
2181	− .0095	0.7	− .795	− 49	+ .0032	+ .05
2957	− .0439	0.8	+ .672	+210	+ .0012	+ .02
2958	− .0433	0.7	+ .672	+210	+ .0006	+ .01
3007	− .0533	0.6	+ .510	+223	+ .0052	+ .08
3015	− .0466	0.8	+ .497	+224	− .0019	− .03
3033	− .0483	0.9	+ .470	+226	− .0010	− .02
3500	− .0850	0.7	− .689	+305	+ .0004	+ .01
3501	− .0798	0.7	− .689	+305	− .0048	− .08
3550	− .0910	1.0	− .886	+331	− .0024	− .05
3563	−0.0962	1.0	−0.901	+335	+0.0017	+0.04

The normal equations are:

$$12.8c + 11.066\mu - 2.6222\pi = - 0.3585 \text{ mm.}$$
$$+ 73.9729\mu - 0.7507\pi = - 1.7391 \text{ mm.}$$
$$+ 6.0363\pi = + 0.1218 \text{ mm.}$$

from which:

$c = -0.00545$ mm.

$\mu = -0.02254$ mm. $= -0''.4689$, or $-1''.711$ per year.

$\pi = +0.01501$ mm. $= +\mathbf{0''.312 \pm 0''.016}$.

Probable error of plate of unit weight

± 0.00179 mm. $= \pm 0''.037$.

β TRIANGULI ($2^h\ 3^m$; $+34°\ 30'$)

This is a star of magnitude 3.08, of type A5, and according to Mitchell (*Astrophysical Journal*, **30**, 240, 1909), is a spectroscopic binary. The plates of the series were measured by Mr. Briggs with the exception of the last four plates which were measured by Mr. Mitchell. The proper motion in right ascension found

TABLE 1

PLATES OF β TRIANGULI

No.	Date.	Hour Angle.	Observers.	Weight.
3069	1916 Sept. 23	$-0^h.1$	M	0.7
3096	Sept. 26	−0.4	L	0.9
3097	Sept. 26	0.0	L	0.7
3576	1917 Jan. 14	−0.1	M	0.7
3584	Jan. 16	−0.1	M	1.0
3601	Jan. 20	−0.1	M	1.0
3604	Jan. 25	0.0	M	1.0
4350	Aug. 26	−0.6	A	1.0
4351	Aug. 26	−0.4	A	0.9
4359	Aug. 27	−1.2	Ol	0.7
4360	Aug. 27	−1.0	Ol	0.7
4375	Aug. 29	−0.9	B	1.0
4376	Aug. 29	−0.7	B	1.0
4377	Aug. 29	−0.5	B	1.0
4887	Dec. 20	−0.4	B	1.0
4888	Dec. 20	−0.2	B	1.0
4904	Dec. 26	−0.7	B	1.0
4905	Dec. 26	−0.4	B	1.0

from the plates is + 0".156 per year, while the value from Boss is + 0".152. The value of the parallax determined at Allegheny Observatory by photography is + 0".006 ± 0".006.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−22.2	−18.8	+0.2452
2	.12	−17.5	+ 3.5	.3227
3	.14	+13.3	−23.5	.1079
4	.10	+26.4	+38.8	+0.3242
Parallax star	0.14	− 1.1	+ 6.6	

TABLE 2

REDUCTIONS FOR β TRIANGULI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3069	−0.0057	0.7	+0.507	−260	+0.0034	+0".06
3096	− .0029	0.9	+ .466	−257	+ .0006	+ .01
3097	− .0018	0.7	+ .466	−257	− .0005	− .01
3576	− .0035	0.7	− .913	−147	+ .0024	+ .04
3584	− .0018	1.0	− .918	−145	+ .0007	+ .01
3601	+ .0022	1.0	− .921	−141	− .0032	− .07
3604	+ .0010	1.0	− .925	−136	− .0019	− .04
4350	+ .0057	1.0	+ .822	+ 77	− .0009	− .02
4351	+ .0068	0.9	+ .822	+ 77	− .0020	− .04
4359	+ .0028	0.7	+ .814	+ 78	+ .0020	+ .04
4360	+ .0012	0.7	+ .814	+ 78	+ .0036	+ .06
4375	+ .0072	1.0	+ .796	+ 80	− .0023	− .05
4376	+ .0055	1.0	+ .796	+ 80	− .0006	− .01
4377	+ .0054	1.0	+ .796	+ 80	− .0005	− .01
4887	+ .0042	1.0	− .759	+193	+ .0018	+ .04
4888	+ .0074	1.0	− .759	+193	− .0014	− .03
4904	+ .0048	1.0	− .811	+199	+ .0013	+ .03
4905	+0.0053	1.0	−0.811	+199	+0.0008	+0.02

The normal equations are:

$$16.3c + 1.614\mu - 0.3532\pi = + 0.0455 \text{ mm.}$$
$$+ 42.0209\mu - 0.1674\pi = + 0.0903 \text{ mm.}$$
$$+ 10.2374\pi = + 0.0065 \text{ mm.}$$

from which:

$c = + 0.00261$ mm.
$\mu = + 0.00205$ mm. $= + 0''.0427$, or $+ 0''.156$ per year.
$\pi = + 0.00076$ mm. $= + \mathbf{0''.016 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00131 \text{ mm.} = \pm 0''.027.$$

LALANDE 4141 ($2^h\ 9^m$; $+23°\ 49'$)

This star of magnitude 6.9 and of type G has a total proper motion $0''.60$. With the Yale heliometer the relative parallax $+ 0''.018 \pm 0''.041$ was determined, and with the spectroscope the absolute value $+ 0''.025$. Miss Hawes measured the McCormick plates with the exception of six plates measured by Mr. Mitchell, and derived the relative parallax $+ 0''.034 \pm 0''.007$ and the proper motion in right ascension $+ 0''.450$ while the corresponding value from Porter is $+ 0''.452$ per year.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−46.7	− 2.6	+0.485
2	.10	+12.8	−42.6	.390
3	.10	+33.9	+45.2	+0.125
Parallax star	0.10	−13.4		

TABLE 1

PLATES OF LALANDE 4141

No.	Date.	Hour Angle.	Observers.	Weight.
4954	1918 Jan. 20	0h0	M	1.0
4979	Jan. 22	0.0	M	1.0
5685	Sept. 14	−0.5	M	1.0
5686	Sept. 14	−0.3	M	1.0
5698	Sept. 21	−0.1	M	1.0
6032	Nov. 30	+0.3	D	1.0
6087	Dec. 17	0.0	H	1.0
6088	Dec. 17	+0.3	H	1.0
6241	1919 Jan. 13	+0.1	H	1.0
6242	Jan. 13	+0.3	H	1.0
7466	Aug. 10	−0.5	H	1.0
7467	Aug. 10	−0.4	H	0.8
7468	Aug. 10	−0.2	H	0.6*
7494	Aug. 15	0.0	D	1.0
7495	Aug. 15	+0.1	D	1.0
8238	Dec. 14	−0.4	M	0.9
8288	Dec. 17	−0.2	M	0.8
8289	Dec. 17	+0.2	A	0.8
8424	1920 Jan. 10	+0.5	A	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR LALANDE 4141

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4954	−0.0132	1.0	−0.924	−424	−0.0003	−0″.01
4979	− .0114	1.0	− .926	−422	− .0020	− .04
5685	+ .0036	1.0	+ .650	−187	− .0005	− .01
5686	+ .0009	1.0	+ .650	−187	+ .0022	+ .05
5698	+ .0037	1.0	+ .563	−180	− .0004	− .01
6032	+ .0069	1.0	− .508	−110	− .0011	− .02
6087	+ .0042	1.0	− .714	− 93	+ .0022	+ .05
6088	+ .0068	1.0	− .714	− 93	− .0004	− .01
6241	+ .0072	1.0	− .906	− 66	+ .0005	+ .01
6242	+ .0058	1.0	− .906	− 66	+ .0019	+ .04
7466	+ .0212	1.0	+ .932	+143	+ .0019	+ .04
7467	+ .0246	0.8	+ .932	+143	− .0015	− .03
7468	+ .0218	0.6	+ .932	+143	+ .0013	+ .02
7494	+ .0260	1.0	+ .910	+148	− .0026	− .05
7495	+ .0232	1.0	+ .910	+148	+ .0002	.00
8238	+ .0292	0.9	− .679	+269	− .0012	− .02
8288	+ .0298	0.8	− .712	+272	− .0017	− .03
8289	+ .0258	0.8	− .712	+272	+ .0023	+ .04
8424	+0.0298	1.0	−0.893	+296	−0.0006	−0.01

The normal equations are:

$$17.9c - 2.155\mu - 2.3215\pi = +0.2182 \text{ mm.}$$
$$+ 86.2309\mu + 5.9703\pi = +0.4925 \text{ mm.}$$
$$+ 11.5569\pi = +0.0236 \text{ mm.}$$

from which:

$c = +0.01311$ mm.

$\mu = +0.00593$ mm. $= +0''.1233$, or $+0''.450$ per year.

$\pi = +0.00161$ mm. $= +$ **0″.034 ± 0″.007.**

Probable error of plate of unit weight

$$\pm 0.00109 \text{ mm.} = \pm 0''.023.$$

δ TRIANGULI ($2^h\ 10^m$; $+33°\ 46'$)

This star has a fairly large proper motion of 1″.15 per year. It is of G type, and of magnitude 5.07. The parallax has been determined with the Yale heliometer by Smith giving the value, + 0″.115 ± 0″.038; and three times with the meridian circle as follows: Flint, + 0″.070 ± 0″.030, Flint, + 0″.151 ± 0″.024, and Jewdokimov, + 0″.053 ± 0″.085. Adams by the spectrograph determines the parallax + 0″.115. Mr. Alden measured the twenty plates of the series. The proper motion in right ascension from this series of plates is + 1″.183 per year, while the value determined by Boss is + 1″.153.

TABLE 1

PLATES OF δ TRIANGULI

No.	Date.	Hour Angle.	Observers.	Weight.
1676	1915 Sept. 13	−1ʰ5	A	0.9
1677	Sept. 13	−1.2	A	0.8
1686	Sept. 14	−0.3	A	0.9
1725	Sept. 21	−0.6	G	0.8
2078	Nov. 27	−0.6	G	0.6
2079	Nov. 27	−0.3	G	0.9
2228	Dec. 26	0.0	M	0.6*
2322	1916 Jan. 17	−0.6	Ol	0.9
2323	Jan. 17	−0.2	Ol	0.9
2342	Jan. 23	−0.2	M	1.0
2906	Aug. 19	−0.5	A	0.6*
2907	Aug. 19	−0.4	A	0.8
2946	Aug. 30	−0.4	A	1.0
2947	Aug. 30	−0.1	A	1.0
3035	Sept. 19	−0.3	A	1.0
3036	Sept. 19	0.0	A	1.0
3545	Dec. 31	−0.3	A	0.9
3546	Dec. 31	0.0	A	1.0
3556	1917 Jan. 3	−0.6	M, A	1.0
3557	Jan. 3	−0.3	A	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−56.7	+22.2	+0.3404
2	.12	−25.7	−47.0	.2194
3	.15	+36.2	+37.2	.2568
4	.10	+46.2	−12.4	+0.1834
Parallax star	0.17	− 7.2	+ 4.5	

TABLE 2

REDUCTIONS FOR δ TRIANGULI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1676	+0.0034	0.9	+0.670	−235	+0.0010	+0″.02
1677	+ .0003	0.8	+ .670	−235	− .0022	− .04
1686	− .0010	0.9	+ .658	−234	− .0035	− .07
1725	+ .0046	0.8	+ .571	−227	+ .0015	+ .03
2078	+ .0068	0.6	− .451	−160	− .0005	− .01
2079	+ .0078	0.9	− .451	−160	+ .0005	+ .01
2228	+ .0117	0.6	− .877	−119	+ .0006	+ .01
2322	+ .0168	0.9	− .917	−109	+ .0044	+ .09
2323	+ .0120	0.9	− .917	−109	− .0004	− .01
2342	+ .0123	1.0	− .927	−103	− .0010	− .02
2906	+ .0577	0.6	+ .886	+106	+ .0007	+ .01
2907	+ .0577	0.8	+ .886	+106	+ .0007	+ .01
2946	+ .0574	1.0	+ .804	+117	− .0008	− .02
2947	+ .0624	1.0	+ .804	+117	+ .0042	+ .09
3035	+ .0595	1.0	+ .587	+137	− .0005	− .01
3036	+ .0583	1.0	+ .587	+137	− .0017	− .04
3545	+ .0685	0.9	− .838	+240	+ .0011	+ .02
3546	+ .0690	1.0	− .838	+240	+ .0016	+ .03
3556	+ .0656	1.0	− .861	+243	− .0021	− .04
3557	+0.0638	0.8	−0.861	+243	−0.0039	−0.07

The normal equations are:

$$17.4c + 1.475\mu - 0.7119\pi = + 0.6281 \text{ mm.}$$
$$+ 55.9652\mu - 3.4195\pi = + 0.9031 \text{ mm.}$$
$$+ 10.3027\pi = - 0.0155 \text{ mm.}$$

from which:

$c = + 0.03503$ mm.
$\mu = + 0.01559$ mm. $= + 0''.3242$, or $+ 1''.153$ per year.
$\pi = + 0.00609$ mm. $= + \mathbf{0''.127 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00145 \text{ mm.} = \pm 0''.030.$$

LALANDE 4268 ($2^h\ 12^m$; $+1°\ 17'$)

The only parallax published for this star is the spectroscopic one of Adams with the absolute value $+ 0''.052$. It is of magnitude, 5.8, of spectral type F5, and of total proper motion $0''.527$. Mr. Olivier measured the McCormick plates, and found a proper motion in right ascension $+ 0''.407$ while the corresponding value from Boss is $+ 0''.367$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−55.8	−23.1	+0.1829
2	.20	−30.6	+22.0	.2128
3	.16	−31.6	−39.1	.1738
4	.10	+37.9	+40.8	.2276
5	.08	+80.1	− 0.6	+0.2029
Parallax star	0.14	+ 2.7	+ 2.8	

TABLE 1

PLATES OF LALANDE 4268

No.	Date.	Hour Angle.	Observers.	Weight.
3068	1916 Sept. 23	−0^{h}8	M	0.7
3125	Oct. 1	−0.9	L	0.6
3605	1917 Jan. 25	+0.3	M	0.9
3606	Jan. 25	+0.6	M	0.9
3616	Jan. 26	0.0	Ol	0.8
3617	Jan. 26	+0.4	Ol	0.9
4333	Aug. 24	+0.4	B	0.7
4342	Aug. 25	0.0	Ol	1.0
4343	Aug. 25	+0.4	Ol	0.7*
4400	Sept. 10	0.0	B	1.0
4401	Sept. 10	+0.4	B	0.9
4906	Dec. 26	−0.1	B	0.9
4907	Dec. 26	+0.3	B	0.9
5664	1918 Aug. 29	−0.1	A	1.0
5665	Aug. 29	+0.3	A	1.0
5709	Sept. 22	0.0	M	0.8
6012	Nov. 26	+0.3	H	0.8
6013	Nov. 26	+0.8	H	1.0
6280	1919 Jan. 20	−0.2	F	0.7
6281	Jan. 20	+0.2	F	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR LALANDE 4268

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3068	−0.0193	0.7	+0.541	−428	−0.0005	−0″.01
3125	− .0195	0.6	+ .429	−420	.0000	.00
3605	− .0157	0.9	− .929	−304	+ .0012	+ .02
3606	− .0147	0.9	− .929	−304	+ .0002	.00
3616	− .0137	0.8	− .929	−303	− .0008	− .01
3617	− .0142	0.9	− .929	−303	− .0002	.00
4333	− .0025	0.7	+ .858	− 93	+ .0009	+ .02
4342	− .0037	1.0	+ .851	− 92	+ .0021	+ .04
4343	+ .0005	0.7	+ .851	− 92	− .0021	− .04
4400	− .0002	1.0	+ .703	− 76	− .0006	− .01
4401	− .0020	0.9	+ .703	− 76	+ .0012	+ .02
4906	+ .0051	0.9	− .795	+ 31	− .0015	− .03
4907	+ .0040	0.9	− .795	+ 31	− .0004	− .01
5664	+ .0209	1.0	+ .822	+277	− .0027	− .06
5665	+ .0179	1.0	+ .822	+277	+ .0003	+ .01
5709	+ .0174	0.8	+ .560	+301	+ .0018	+ .03
6012	+ .0217	0.8	− .441	+366	+ .0001	.00
6013	+ .0224	1.0	− .441	+366	− .0006	− .01
6280	+ .0227	0.7	− .923	+421	+ .0016	+ .03
6281	+0.0241	1.0	−0.923	+421	+0.0002	0.00

The normal equations are:

$$17.2c + 2.453\mu - 0.9343\pi = + 0.0572 \text{ mm.}$$
$$+ 135.8010\mu + 0.2097\pi = + 0.7341 \text{ mm.}$$
$$+ 10.5596\pi = + 0.0081 \text{ mm.}$$

from which:

$c = + 0.00261$ mm.

$\mu = + 0.00536$ mm. $= + 0''.1114$, or $+ 0''.407$ per year.

$\pi = + 0.00089$ mm. $= + \mathbf{0''.019 \pm 0''.005}$.

Probable error of plate of unit weight

$$\pm 0.00084 \text{ mm.} = \pm 0''.017.$$

o CETI ($2^h\ 14^m$; $-3°\ 25'$)

Mira, the Wonderful, in the constellation of Cetus is thoroughly well known. The first plates of the present series were taken in September 1914, when the variable was near a minimum, and when the magnitude was approximately 9.0. No rotating sector was then used. The last plates of the series in December and January, 1915–16, were obtained when the star was near maximum with the magnitude 3.0, and the rotating sector necessarily was used. The diameters of the images of Mira on the photographic plates were kept as nearly constant as possible. The star is of Md type, and with a total proper motion of 0″.24. The only trigonometric value of the parallax so far found is that of Russell, whose parallax by means of photography is + 0″.136

TABLE 1

PLATES OF o CETI

No.	Date.	Hour Angle.	Observers.	Weight.
233	1914 Sept. 13	−0ʰ4	M, A	0.7
244	Sept. 14	−1.4	M, G	0.7
264	Sept. 19	−1.1	G, Ol	0.7
663	Dec. 14	+0.3	Ol	0.8
707	Dec. 23	+1.1	A	0.8
744	1915 Jan. 7	−0.6	Ol	0.7*
766	Jan. 9	+0.4	A	0.7
780	Jan. 13	−0.2	M	0.8
791	Jan. 14	−0.3	Ol	1.0
1575	Aug. 23	−0.9	A	0.9
1576	Aug. 23	−0.4	A	1.0
1633	Sept. 9	−1.3	M	0.9
1634	Sept. 9	−0.8	M	0.9
1712	Sept. 17	−0.7	M	1.0
1713	Sept. 17	−0.2	M	1.0
2231	Dec. 26	−0.2	M	0.9
2249	1916 Jan. 2	−0.3	M	1.0
2343	Jan. 23	+0.3	M	1.0
2344	Jan. 23	+0.8	M	1.0

* One exposure.

$\pm 0''.035$. A result by Kostinsky gives the value of the absolute parallax $+ 0''.02 \pm 0''.02$. The plates of the present series, nineteen in number, were measured by Mr. Mitchell. The

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−58.3	+32.4	+0.208
2	.13	+ 5.3	−52.1	.237
3	.16	+10.0	+ 1.3	.260
4	.10	+43.0	+18.4	+0.295
Parallax star	0.16	+ 4.4	+ 0.2	

TABLE 2

REDUCTIONS FOR o CETI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
233	−0.0092	0.7	+0.677	−211	+0.0011	+0″.02
244	− .0069	0.7	+ .666	−210	− .0012	− .02
264	− .0072	0.7	+ .605	−205	− .0011	− .02
663	− .0140	0.8	− .670	−119	+ .0019	+ .03
707	− .0099	0.8	− .763	−110	− .0024	− .04
744	− .0143	0.7	− .875	− 95	+ .0016	+ .03
766	− .0114	0.7	− .885	− 93	− .0013	− .02
780	− .0157	0.8	− .903	− 89	+ .0029	+ .05
791	− .0114	1.0	− .907	− 88	− .0014	− .03
1575	− .0088	0.9	+ .872	+133	+ .0012	+ .02
1576	− .0088	1.0	+ .872	+133	+ .0012	+ .02
1633	− .0062	0.9	+ .724	+150	− .0018	− .03
1634	− .0075	0.9	+ .724	+150	− .0015	− .01
1712	− .0070	1.0	+ .633	+158	− .0013	− .03
1713	− .0098	1.0	+ .633	+158	+ .0015	+ .03
2231	− .0136	0.9	− .787	+258	+ .0011	+ .02
2249	− .0112	1.0	− .842	+265	− .0015	− .03
2343	− .0116	1.0	− .927	+286	− .0013	− .03
2344	−0.0143	1.0	−0.927	+286	+0.0014	+0.03

proper motion in right ascension from the photographs is $-0''.001$ per year, which agrees exactly with the value from Boss.

The normal equations are:

$$16.5c + 9.957\mu - 1.8225\pi = -0.1726 \text{ mm.}$$
$$+ 55.6675\mu - 2.1413\pi = -0.1084 \text{ mm.}$$
$$+ 10.4462\pi = +0.0494 \text{ mm.}$$

from which:

$c = -0.01012$ mm.
$\mu = -0.00002$ mm. $= -0''.0005$, or $-0''.001$ per year.
$\pi = +0.00295$ mm. $= +\mathbf{0''.061 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00106 \text{ mm.} = \pm 0''.022.$$

PIAZZI 2^h 123 (2^h 30^m; $+6°$ 24′)

This is a G5 type star of 5.92 magnitude, and with a very large proper motion which amounts to $2''.34$ per year. Van Maanen finds that a star of 11.5 magnitude 13 seconds following has almost the same proper motion. For the companion, the proper motion amounts to $2''.63$. Though widely separated, the two stars must form a physical system. Mr. Olivier measured the McCormick series of plates, and found a parallax of $+0''.137 \pm 0''.005$, and a proper motion in right ascension of $+1''.791$ per year, while the value due to Boss is $+1''.802$.

The parallax has been determined as follows:

Parallax.	Authority.	Method.
$+0''.11 \pm 0''.043$	Flint	Meridian Circle
$+ .138 \pm .031$	Elkin-Smith	Heliometer
$- .092 \pm .101$	Jewdokimov	Meridian Circle
$+ .145 \pm .008$	Allegheny	Photography
$+ .144$	Mt. Wilson	Spectrograph

TABLE 1

PLATES OF PIAZZI 2^h 123

No.	Date.	Hour Angle.	Observers.	Weight.
1698	1915 Sept. 15	-1^h3	M	0.7
1737	Sept. 22	+0.2	Ol	1.0
2116	Dec. 6	+0.1	G	0.6
2117	Dec. 6	+0.6	G	0.9
2324	1916 Jan. 17	+0.4	G	0.5
2325	Jan. 17	+0.8	G	0.5*
2871	Aug. 13	−0.8	Ol	0.6
2885	Aug. 17	−0.8	Ol	0.8
2886	Aug. 17	−0.2	Ol	0.8
2986	Sept. 9	−0.5	M	0.8
2987	Sept. 9	0.0	M	1.0
3551	1917 Jan. 2	−0.1	L	0.9
3552	Jan. 2	+0.3	M	1.0
3595	Jan. 19	−0.3	Ol	1.0
3596	Jan. 19	+0.1	Ol, M	0.9
4299	Aug. 19	−0.8	Ol	0.8
4300	Aug. 19	−0.3	Ol	1.0
4320	Aug. 21	−0.6	Ol	0.8
4321	Aug. 21	−0.2	Ol	1.1†
4867	Dec. 14	−0.4	Ol	0.7*
5093	1918 Feb. 17	+1.9	M	0.9
5110	Feb. 18	+1.9	A	0.6

* One exposure. † Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.17	−55.7	+ 2.1	+0.1978
2	.13	−11.9	+39.2	.0373
3	.14	− 1.9	−54.1	.5300
4	.16	+69.5	+12.8	+0.2349
Parallax star	0.13	+ 3.9	−23.8	

TABLE 2

REDUCTIONS FOR PIAZZI 2^h 123

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1698	−0.0311	0.7	+0.709	−441	−0.0015	−0″.03
1737	− .0297	1.0	+ .626	−424	+ .0006	+ .01
2116	− .0171	0.6	− .517	−349	− .0019	− .03
2117	− .0206	0.9	− .517	−349	+ .0016	+ .03
2324	− .0129	0.5	− .907	−307	+ .0012	+ .02
2325	− .0104	0.5	− .907	−307	− .0012	− .02
2871	+ .0499	0.6	+ .944	− 98	− .0001	.00
2885	+ .0528	0.8	+ .929	− 94	− .0021	− .04
2886	+ .0488	0.8	+ .929	− 94	+ .0019	+ .04
2986	+ .0550	0.8	+ .764	− 71	.0000	.00
2987	+ .0546	1.0	+ .764	− 71	+ .0004	+ .01
3551	+ .0736	0.9	− .823	+ 44	− .0019	− .04
3552	+ .0206	1.0	− .823	+ 44	+ .0011	+ .02
3595	+ .0739	1.0	− .917	+ 61	+ .0012	+ .02
3596	+ .0755	0.9	− .917	+ 61	− .0004	− .01
4299	+ .1386	0.8	+ .921	+273	− .0014	− .03
4300	+ .1379	1.0	+ .921	+273	− .0007	− .01
4320	+ .1362	0.8	+ .911	+275	+ .0014	+ .03
4321	+ .1366	1.1	+ .911	+275	+ .0010	+ .02
4867	+ .1563	0.7	− .623	+390	− .0017	− .03
5093	+ .1667	0.9	− .901	+453	+ .0009	+ .02
5110	+0.1691	0.6	−0.886	+456	−0.0006	−0.01

The normal equations are:

$$17.9c + 2.675\mu + 1.1719\pi = + 1.2655 \text{ mm.}$$
$$+ 132.6345\mu - 2.5439\pi = + 3.2902 \text{ mm.}$$
$$+ 12.3951\pi = + 0.0999 \text{ mm.}$$

from which:

$c = + 0.06674$ mm.

$\mu = + 0.02359$ mm. $= + 0''.4906$, or $+ 1''.791$ per year.

$\pi = + 0.00659$ mm. $= + \mathbf{0''.137 \pm 0''.005}$

Probable error of plate of unit weight

$$\pm 0.00082 \text{ mm.} = \pm 0''.017.$$

γ CETI ($2^h\ 38^m$; $+2°\ 49'$)

This is a double star Σ 299, but according to Burnham, "the angles are very discordant for so easy a pair." The principal star is of 3.6 magnitude, and of type A, while the companion is of magnitude 6.8, and is at a distance of 3″, at position angle 290°. The orbital motion is very slow. The parallax published by the Yale heliometer is $+ 0''.119 \pm 0''.017$. The Allegheny value by photography is $+ 0''.014 \pm 0''.008$. The present series of plates were measured by Mr. Mitchell, who finds a parallax of $+ 0''.037 \pm 0''.008$. Boss gives the proper motion in right ascension to be $- 0''.147$. The least square solution from the photographs gives $- 0''.059$. In order to check up this photographic value, two extra plates were taken in February, 1918. Their solution compared with plates 729 to 847 inclusive, taken three years previously, give a proper motion of $- 0''.060$, in close agreement with the least square solution. The reason for the disagreement with Boss is difficult to explain. On account of the slow orbital motion, it cannot be due to this cause. Four comparison stars were used for the photographic solution, and it possible that there might be a proper motion of one or more of these stars. The plates were compared with this idea in view, and no trace was found of any appreciable proper motion of any of the comparison stars.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−32.7	+24.0	+0.246
2	.16	− 1.8	−58.2	.247
3	.14	+11.3	+ 4.5	.252
4	.13	+23.2	+29.7	+0.255
Parallax star	0.15	+ 0.3	+ 0.3	

TABLE 1

PLATES OF γ CETI

No.	Date.	Hour Angle.	Observers.	Weight.
221	1914 Sept. 9	$-0^h.6$	M	0.5
222	Sept. 9	−0.1	M	0.7*
579	Nov. 13	−0.6	G	0.7
646	Nov. 25	−0.2	A	1.0
710	Dec. 26	−0.8	G	0.5
729	Dec. 30	−0.2	Ol	0.7
825	1915 Jan. 28	+0.8	A	1.0
837	Feb. 4	+0.8	Ol	0.7
847	Feb. 7	+0.7	M	0.7
1585	Aug. 25	−1.2	A	0.7
1586	Aug. 25	−0.8	A	0.7*
1635	Sept. 9	−0.6	M	0.7
1636	Sept. 9	−0.2	M	0.5*
1699	Sept. 15	−0.6	M	0.7
2136	Dec. 9	−0.3	M	0.7
2137	Dec. 9	+0.2	M	0.7
2233	Dec. 26	+0.3	M	0.9
2345	1916 Jan. 23	+0.8	M	0.9

* One exposure.

TABLE 2

REDUCTIONS FOR γ CETI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
221	+0.0158	0.5	+0.790	−265	−0.0028	−0″.04
222	+ .0154	0.7	+ .790	−265	− .0024	− .04
579	+ .0091	0.7	− .142	−200	+ .0017	+ .03
646	+ .0106	1.0	− .334	−188	− .0002	.00
710	+ .0110	0.5	− .740	−157	− .0016	− .02
729	+ .0080	0.7	− .779	−153	+ .0013	+ .02
825	+ .0082	1.0	− .935	−124	+ .0006	+ .01
837	+ .0099	0.7	− .938	−117	− .0011	− .02
847	+ .0056	0.7	− .934	−114	+ .0032	+ .05
1585	+ .0097	0.7	+ .905	+ 85	+ .0008	+ .01
1586	+ .0116	0.7	+ .905	+ 85	− .0011	− .02
1635	+ .0090	0.7	+ .792	+100	+ .0012	+ .02
1636	+ .0082	0.5	+ .792	+100	+ .0020	+ .03
1699	+ .0080	0.7	+ .732	+106	+ .0020	+ .03
2136	+ .0066	0.7	− .534	+191	+ .0005	+ .01
2137	+ .0096	0.7	− .534	+191	− .0025	− .04
2233	+ .0072	0.9	− .738	+208	− .0006	− .01
2345	+0.0074	0.9	−0.924	+236	−0.0013	−0.02

The normal equations are:

$$13.0c - 1.371\mu - 2.1597\pi = + 0.1212 \text{ mm.}$$
$$+ 38.0498\mu + 0.2011\pi = - 0.0423 \text{ mm.}$$
$$+ 7.6062\pi = - 0.0071 \text{ mm.}$$

from which:

$c = + 0.00954$ mm.

$\mu = - 0.00078$ mm. $= - 0''.0161$, or $- 0''.059$ per year.

$\pi = + 0.00179$ mm. $= + \mathbf{0''.037 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00102 \text{ mm.} = \pm 0''.021.$$

α CETI ($2^h\ 57^m$; $+3°\ 41'$)

The only values of the parallax of this star so far published are the spectroscopic one of Adams who gives the result $+ 0''.023$,

and the Allegheny value by photography of $0''.000 \pm 0''.005$. The star is of Ma type, of magnitude 2.82, and of small proper motion $0''.08$ per year. The sixteen plates of the series were measured by Mr. Alden. Boss finds the proper motion in right ascension to be $-0''.013$ per year.

TABLE 1

PLATES OF α CETI

No.	Date.	Hour Angle.	Observers.	Weight.
234	1914 Sept. 13	$-0^h.1$	M, A	0.5*
257	Sept. 15	−1.5	Ol, A	0.9
265	Sept. 19	−1.3	G, Ol	1.0
319	Sept. 26	−1.4	M	0.7*
664	Dec. 14	+0.6	Ol	0.8
674	Dec. 15	+0.2	A	0.9
711	Dec. 26	−0.5	G	0.5*
767	1915 Jan. 9	+0.4	A	1.0
849	Feb. 8	+0.6	Ol	0.7*
859	Feb. 9	+0.6	M	1.0
874	Feb. 10	+0.7	M	0.8
1577	Aug. 23	−0.4	A	0.9
1587	Aug. 25	−0.6	A	0.8
1588	Aug. 25	−0.1	A	1.0
1680	Sept. 13	+0.5	A	1.0
1681	Sept. 13	+1.0	A	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−40.4	−11.0	+0.1149
2	.15	−17.7	+ 1.2	.1724
3	.16	+ 9.5	+50.9	.2983
4	.20	+10.5	−18.8	.1870
5	.23	+38.1	−22.3	+0.2274
Parallax star	0.28	+ 5.8	+ 5.5	

TABLE 2

REDUCTIONS FOR α CETI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
234	0.0000	0.5	+0.802	−165	+0.0019	+0″.03
257	+ .0016	0.9	+ .784	−163	+ .0003	+ .01
265	+ .0034	1.0	+ .743	−159	− .0015	− .03
319	+ .0028	0.7	+ .664	−152	− .0010	− .02
664	+ .0006	0.8	− .546	− 73	+ .0004	+ .01
674	− .0013	0.9	− .559	− 72	+ .0024	+ .04
711	+ .0008	0.5	− .695	− 61	+ .0002	+ .03
767	− .0020	1.0	− .831	− 47	+ .0029	+ .06
849	+ .0027	0.7	− .945	− 17	− .0018	− .03
859	+ .0039	1.0	− .945	− 16	− .0030	− .06
874	+ .0015	0.8	− .944	− 15	− .0006	− .01
1577	+ .0068	0.9	+ .944	+179	− .0040	− .06
1587	+ .0028	0.8	+ .936	+181	.0000	.00
1588	+ .0018	1.0	+ .936	+181	+ .0010	+ .02
1680	+ .0011	1.0	+ .804	+200	+ .0017	+ .03
1681	+0.0016	0.9	+0.804	+200	+0.0012	+0.02

The normal equations are:

$$13.4c + 1.317\mu + 1.8963\pi = + 0.0242 \text{ mm.}$$
$$+ 25.6422\mu + 5.5864\pi = + 0.0127 \text{ mm.}$$
$$+ 9.0255\pi = + 0.0117 \text{ mm.}$$

from which:

$c = + 0.00167$ mm.

$\mu = + 0.00023$ mm. $= + 0''.0048$, or $+ 0''.018$ per year.

$\pi = + 0.00080$ mm. $= \mathbf{+ 0''.017 \pm 0''.010.}$

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

γ PERSEI ($2^h\ 57^m$; $+53°\ 6'$)

This star is a long period spectroscopic binary of Gp type, of magnitude 3.08, and of very small proper motion 0″.01 per year. Mt. Wilson finds the spectroscopic parallax + 0″.025 while Alle-

gheny by photography derives the relative value $+0''.010 \pm 0''.006$. The series of plates were measured by Mr. Alden. The proper motion in right ascension determined by Boss is $+0''.004$ per year.

TABLE 1

PLATES OF γ PERSEI

No.	Date.	Hour Angle.	Observers.	Weight.
341	1914 Sept. 28	$-0^h.8$	G	1.0
392	Oct. 11	−0.6	A	0.6*
759	1915 Jan. 8	−0.5	G	0.7*
776	Jan. 10	−0.3	M	1.0
781	Jan. 13	−0.2	A	0.8
1679	Sept. 13	−0.1	A	0.9
1687	Sept. 14	−0.4	A	0.7
2250	1916 Jan. 2	−0.6	M	0.8
2251	Jan. 2	−0.3	M	0.7
2285	Jan. 4	−0.7	A	1.0
2286	Jan. 4	−0.2	A, Ol	1.0
2360	Feb. 3	+0.1	M	0.6*
2971	Sept. 15	−0.8	M	0.8
3037	Sept. 19	−0.4	A	0.8
3126	Oct. 1	−0.9	L	0.7
3127	Oct. 1	−0.5	L	0.8
3564	1917 Jan. 6	−0.4	A	1.0
3565	Jan. 6	0.0	A	1.0
3591	Jan. 17	−0.9	Ol	0.6*
3602	Jan. 20	−0.5	M	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−78.5	+52.9	+0.3446
2	.17	−43.9	−21.2	.0316
3	.12	+29.6	− 3.0	.2288
4	.12	+44.9	−18.8	.1732
5	.14	+47.9	− 9.9	+0.2218
Parallax star	0.18	− 3.2	+11.4	

TABLE 2

REDUCTIONS FOR γ PERSEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
341	+0.0099	1.0	+0.642	−484	+0.0013	+0″.03
392	+ .0043	0.6	+ .466	−467	+ .0068	+ .11
759	+ .0110	0.7	− .821	−378	− .0005	− .01
776	+ .0110	1.0	− .837	−376	− .0005	− .01
781	+ .0112	0.8	− .859	−373	− .0007	− .01
1679	+ .0122	0.9	+ .807	−130	− .0028	− .06
1687	+ .0155	0.7	+ .798	−129	− .0061	− .11
2250	+ .0105	0.8	− .764	− 19	− .0018	− .03
2251	+ .0091	0.7	− .764	− 19	− .0004	− .01
2285	+ .0084	1.0	− .783	− 17	+ .0003	+ .01
2286	+ .0108	1.0	− .783	− 17	− .0021	− .04
2360	+ .0046	0.6	− .944	+ 13	+ .0039	+ .06
2971	+ .0038	0.8	+ .867	+228	+ .0038	+ .07
3037	+ .0070	0.8	+ .740	+242	+ .0005	+ .01
3126	+ .0085	0.7	+ .597	+254	− .0011	− .02
3127	+ .0078	0.8	+ .597	+254	− .0004	− .01
3564	+ .0042	1.0	− .808	+351	+ .0026	+ .05
3565	+ .0070	1.0	− .808	+351	− .0002	.00
3591	+ .0107	0.6	− .888	+362	− .0039	− .06
3602	+0.0052	0.9	−0.904	+365	+0.0016	+0.03

The normal equations are:

$$16.4c + 0.395\mu - 3.9521\pi = + 0.1418 \text{ mm.}$$
$$+ 137.6030\mu - 3.0666\pi = - 0.0668 \text{ mm.}$$
$$+ 10.0618\pi = - 0.0320 \text{ mm.}$$

from which:

$c = + 0.00868$ mm.

$\mu = - 0.00051$ mm. $= - 0''.0106$, or $- 0''.039$ per year.

$\pi = + 0.00007$ mm. $= + \mathbf{0''.002 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00172 \text{ mm.} = \pm 0''.036.$$

ρ PERSEI ($2^h\ 58^m$; $+38°\ 27'$)

Russell, by photography finds the parallax of this variable to be $+ 0''.083 \pm 0''.040$. Adams by the spectroscopic method, gives the parallax between $+ 0''.011$ and $+ 0''.017$, depending on the apparent magnitude assumed for the variable, which has a range from 3.4 to 4.2 magnitude. The star is of Mb type, and of total proper motion $0''.17$ per year. The twenty plates of the series were measured by Mr. Lamb. The proper motion in right ascension from the present photographs is $+ 0''.105$ per year, while the value of Boss is $+ 0''.135$.

TABLE 1

PLATES OF ρ PERSEI

No.	Date.	Hour Angle.	Observers.	Weight.
792	1915 Jan. 14	$-0^h.2$	A	1.0
822	Jan. 25	−0.6	Ol	0.6*
823	Jan. 25	−0.3	Ol, M	1.0
824	Jan. 28	−0.5	Ol	1.0
834	Jan. 29	−0.4	Ol	0.8
1646	Sept. 10	−1.5	Ol	0.7
1647	Sept. 10	−0.8	Ol	0.5
1667	Sept. 12	−1.2	Ol	0.8
1668	Sept. 12	−0.7	Ol	0.9
1726	Sept. 21	−0.8	G	0.7
2245	Dec. 31	−0.5	Ol	1.0
2266	1916 Jan. 3	−0.9	G	1.0
2318	Jan. 14	−0.2	G	0.8
2968	Sept. 4	−0.2	L	1.0
3027	Sept. 18	−0.2	L	0.9
3047	Sept. 20	−0.5	L	0.9
3048	Sept. 20	−0.9	L	0.6*
3083	Sept. 24	−0.6	L	0.7*
3084	Sept. 24	−0.2	L	0.8
3098	Sept. 28	−0.4	L	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−53.9	− 9.4	+0.1604
2	.11	−31.0	−23.6	.1710
3	.10	−22.9	+17.9	.1544
4	.10	+10.8	−18.3	.1769
5	.08	+47.8	− 7.0	.1790
6	.18	+49.2	+40.4	+0.1583
Parallax star	0.18	+ 0.77	− 0.88	

TABLE 2

REDUCTIONS FOR ρ PERSEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
792	+0.0051	1.0	−0.864	−288	−0.0012	−0″.02
822	+ .0035	0.6	− .922	−277	+ .0003	+ .01
823	+ .0022	1.0	− .922	−277	+ .0018	+ .04
824	+ .0071	1.0	− .932	−274	− .0031	− .06
834	+ .0028	0.8	− .935	−273	+ .0010	+ .02
1646	+ .0124	0.7	+ .837	− 49	− .0020	− .05
1647	+ .0129	0.5	+ .837	− 49	− .0016	− .05
1667	+ .0060	0.8	+ .819	− 47	+ .0029	+ .06
1668	+ .0083	0.9	+ .819	− 47	+ .0012	+ .02
1726	+ .0073	0.7	+ .730	− 38	+ .0016	+ .04
2245	+ .0056	1.0	− .741	+ 63	+ .0033	+ .07
2266	+ .0116	1.0	− .762	+ 65	− .0027	− .05
2318	+ .0084	0.8	− .863	+ 77	+ .0004	+ .01
2968	+ .0156	1.0	+ .877	+311	− .0010	− .02
3027	+ .0150	0.9	+ .754	+325	− .0003	− .01
3047	+ .0145	0.9	+ .733	+327	+ .0001	.00
3048	+ .0186	0.6	+ .733	+327	− .0023	− .06
3083	+ .0155	0.7	+ .688	+331	− .0006	− .01
3084	+ .0134	0.8	+ .688	+331	+ .0010	+ .02
3098	+0.0136	1.0	+0.664	+333	+0.0010	+0.02

The normal equations are:

$$16.7c + 7.242\mu + 1.0462\pi = + 0.1636 \text{ mm.}$$
$$+ 98.8402\mu + 22.4912\pi = + 0.2342 \text{ mm.}$$
$$+ 10.9918\pi = + 0.0560 \text{ mm.}$$

from which:

$c = + 0.00911$ mm.
$\mu = + 0.00138$ mm. $= + 0''.0288$, or $+ 0''.105$ per year.
$\pi = + 0.00140$ mm. $= + \mathbf{0''.029 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.030.$$

α PERSEI ($3^h\ 17^m$; $+49°\ 30'$)

The measured values of the parallax of this star of magnitude 1.90, of spectral type F5, and of small proper motion and radial velocity are discordant. The measures are:

Authority.	Method.	Parallax.
Pritchard	Photography	$+0''.087 \pm 0''.021$
Flint	Meridian circle	$+ .109 \pm .025$
Slocum and Mitchell	Photography	$- .008 \pm .011$
Mt. Wilson	Spectrograph	$+ .023$

The McCormick plates were measured by Mr. Alden except the four last measured by Mr. Mitchell. The relative parallax

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−36.2	−25.9	+0.1722
2	.10	−32.5	+26.1	0.1680
3	.14	−14.4	+ 3.1	0.1679
4	.17	+20.6	−11.4	0.1654
5	.15	+23.8	−18.2	0.1656
6	.12	+38.7	+26.3	+0.1610
Parallax star	0.15	− 0.5	− 0.2	

$+ 0''.013 \pm 0''.010$ resulted, with a proper motion in right ascension $+ 0''.032$, while the corresponding value from Boss is $+ 0''.027$.

TABLE 1

PLATES OF α PERSEI

No.	Date.	Hour Angle.	Observers.	Weight.
3195	1916 Oct. 14	$-0^h.5$	M	1.0
3196	Oct. 14	−0.1	M	1.0
3206	Oct. 17	−0.4	L	1.0
3207	Oct. 17	−0.1	L	1.0
3578	1917 Jan. 14	−0.4	M	0.8
3602	Jan. 20	−0.3	A	1.0
3603	Jan. 20	0.0	A	0.8
3624	Jan. 28	−0.9	M	0.9
3625	Jan. 28	−0.6	M	0.9
3635	Jan. 30	−0.8	M	0.8
3636	Jan. 30	−0.5	M	0.8
4352	Aug. 26	−1.1	A	1.0
4353	Aug. 26	−0.8	A	1.0
4368	Aug. 28	−0.7	B	0.9
4369	Aug. 28	−0.4	B	0.8
4426	Sept. 12	−0.7	A	1.0
4427	Sept. 12	−0.3	A	1.0
4923	1918 Jan. 10	−0.2	A	1.0
4924	Jan. 10	−0.1	A	0.6*
4955	Jan. 20	−0.7	M	0.7
4956	Jan. 20	−0.3	M	1.0
5656	Aug. 23	−1.0	A	1.0
5657	Aug. 23	−0.6	A	1.0
5666	Aug. 29	−0.3	A	1.0
5667	Aug. 29	0.0	A	0.7*

* One exposure.

The normal equations are:

$$22.7c - 0.487\mu + 2.4403\pi = + 0.0248 \text{ mm.}$$
$$+ 120.9072\mu + 15.6584\pi = + 0.0599 \text{ mm.}$$
$$+ 16.3595\pi = + 0.0196 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR α PERSEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in (Days t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3195	+0.0006	1.0	+0.489	−288	−0.0004	−0″.01
3196	− .0038	1.0	+ .489	−288	+ .0040	+ .08
3206	+ .0030	1.0	+ .444	−285	− .0029	− .06
3207	− .0014	1.0	+ .444	−285	+ .0015	+ .03
3578	− .0045	0.8	− .841	−196	+ .0042	+ .08
3602	− .0022	1.0	− .884	−190	+ .0019	+ .04
3603	+ .0026	0.8	− .884	−190	− .0029	− .05
3624	+ .0040	0.9	− .925	−182	− .0043	− .09
3625	− .0022	0.9	− .925	−182	+ .0019	+ .04
3635	− .0013	0.8	− .933	−180	+ .0010	+ .02
3636	+ .0010	0.8	− .933	−180	− .0013	− .02
4352	+ .0014	1.0	+ .956	+ 28	+ .0004	+ .01
4353	+ .0008	1.0	+ .956	+ 28	+ .0010	+ .02
4368	− .0008	0.9	+ .949	+ 30	+ .0026	+ .05
4369	+ .0044	0.8	+ .949	+ 30	− .0026	− .05
4426	+ .0043	1.0	+ .859	+ 45	− .0025	− .05
4427	+ .0054	1.0	+ .859	+ 45	− .0036	− .07
4923	+ .0018	1.0	− .805	+165	− .0006	− .01
4924	+ .0053	0.6	− .805	+165	− .0041	− .07
4955	− .0044	0.7	− .882	+175	+ .0056	+ .10
4956	+ .0026	1.0	− .882	+175	− .0014	− .03
5656	+ .0014	1.0	+ .966	+390	+ .0019	+ .04
5657	+ .0038	1.0	+ .966	+390	− .0005	− .01
5666	+ .0008	1.0	+ .946	+396	+ .0025	+ .05
5667	+0.0050	0.7	+0.946	+396	−0.0017	−0.03

from which:

$c = +0.00103$ mm.

$\mu = +0.00042$ mm. $= +0''.0087$, or $+0''.032$ per year.

$\pi = +0.00065$ mm. $= +\mathbf{0''.013 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00177 \text{ mm.} = \pm 0''.037.$$

LALANDE 6320 ($3^h\ 20^m$; $-5°\ 42'$)

This star of fairly large proper motion 0″.82 per year, is of magnitude 7.9, and of K5 type. Two trigonometric determinations of its parallax have been made: the Yale heliometer in the hands of Chase giving the result + 0″.061 ± 0″.016, and the

TABLE 1

PLATES OF LALANDE 6320

No.	Date.	Hour Angle.	Observers.	Weight.
1748	1915 Sept. 23	−0ʰ8	M	1.0
1786	Oct. 8	−0.4	G	0.5*
2189	Dec. 21	−0.2	G	0.8
2190	Dec. 21	+0.2	G	0.5*
2304	1916 Jan. 13	0.0	A	0.9
2305	Jan. 13	+0.5	A	0.9
2959	Sept. 3	−0.6	A	0.9
2960	Sept. 3	−0.2	A	1.0
2961	Sept. 3	+0.2	A	1.0
3018	Sept. 17	−0.4	A	0.9
3019	Sept. 17	0.0	A	0.9
3566	1917 Jan. 6	+0.1	A	1.0
3567	Jan. 6	+0.3	A	1.0
3607	Jan. 25	+0.1	L	1.0
3608	Jan. 25	+0.5	L	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−47.1	− 3.6	+0.2511
2	.11	+ 4.2	+55.7	.1714
3	.11	+ 5.3	−20.9	.2035
4	.09	+14.7	− 6.5	.1873
5	.09	+22.9	−24.7	+0.1867
Parallax star	0.17	− 3.0	− 1.4	

meridian circle by Jewdokimov giving the parallax + 0″.074 ± 0″.099. Adams finds the spectroscopic value of + 0″.058. Mr. Alden measured the fifteen plates of the series, and found the proper motion in right ascension to be − 0″.266 per year, a value which agrees with that determined by Porter.

TABLE 2

REDUCTIONS FOR LALANDE 6320

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1748	−0.0044	1.0	+0.770	−273	−0.0025	−0″.05
1786	− .0020	0.5	+ .592	−258	+ .0009	+ .01
2189	− .0073	0.8	− .566	−184	+ .0016	+ .03
2190	− .0085	0.5	− .566	−184	+ .0004	+ .01
2304	− .0096	0.9	− .823	−161	+ .0008	+ .02
2305	− .0107	0.9	− .823	−161	− .0002	.00
2959	− .0102	0.9	+ .923	+ 73	+ .0034	+ .06
2960	− .0151	1.0	+ .923	+ 73	− .0015	− .03
2961	− .0136	1.0	+ .923	+ 73	.0000	.00
3018	− .0114	0.9	+ .820	+ 87	+ .0030	+ .06
3019	− .0171	0.9	+ .820	+ 87	− .0027	− .05
3566	− .0260	1.0	− .765	+198	− .0031	− .06
3567	− .0226	1.0	− .765	+198	+ .0003	+ .01
3607	− .0224	1.0	− .910	+217	+ .0016	+ .03
3608	−0.0247	1.0	−0.910	+217	−0.0007	−0.01

The normal equations are:

$$13.3c + 2.673\mu - 0.3485\pi = - 0.1930 \text{ mm.}$$
$$+ 40.0146\mu - 2.8675\pi = - 0.1858 \text{ mm.}$$
$$+ 8.9114\pi = + 0.0408 \text{ mm.}$$

from which:

$c = - 0.01373$ mm.

$\mu = - 0.00352$ mm. $= - 0''.0730$, or $- 0''.266$ per year.

$\pi = + 0.00291$ mm. $= + \mathbf{0''.060 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00137 \text{ mm.} = \pm 0''.028.$$

ϵ ERIDANI ($3^h\ 28^m$; $-9°\ 47'$)

This star is of exceptional interest on account of its comparatively large parallax which is about equal to that of 61 Cygni. Two trigonometric parallaxes have already been found: that of Flint with meridian circle giving a value of $+ 0''.379 \pm 0''.025$, and that with the Yale heliometer by Smith with the value $+ 0''.307 \pm 0''.014$. Adams further gives the parallax by the spectroscopic method of $+ 0''.331$. The star has a total proper motion of $0''.97$ per year, it is of type K, and of magnitude 3.81. It is interesting to note that both ϵ and δ Eridani (see below),

TABLE 1

PLATES OF ϵ ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
223	1914 Sept. 9	-0^h1	M	0.5*
247	Sept. 14	−0.6	M, G	0.7
393	Oct. 11	0.0	A	0.7
410	Oct. 19	−0.3	G	0.9
439	Oct. 30	+0.4	A	1.0
675	Dec. 15	+0.7	M	0.7
730	Dec. 30	0.0	Ol	0.8
848	1915 Feb. 7	+0.4	M	0.7*
884	Feb. 11	+0.5	Ol	0.7
891	Feb. 18	+0.9	M	1.0
1637	Sept. 9	−0.4	M	0.8
1638	Sept. 9	+0.1	M	0.8
1701	Sept. 15	0.0	M	1.0
1702	Sept. 15	+0.4	M	0.7*
1714	Sept. 17	−0.8	M	1.0
1715	Sept. 17	−0.5	M	1.0
3597	1917 Jan. 19	−0.3	M	0.9
3598	Jan. 19	0.0	Ol	0.8
3628	Jan. 28	+0.5	M	0.8
3629	Jan. 28	+0.8	M	0.8

* One exposure.

are of type K, of large proper motion, and of large parallax, though the parallax of ϵ Eridani is much greater than that of δ Eridani. The twenty plates of the series were measured by Mr. Mitchell, who finds the proper motion in right ascension to be $-0''.986$ per year, while Boss gives the value $-0''.971$.

TABLE 2

REDUCTIONS FOR ϵ ERIDANI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
223	−0.0380	0.5	+0.904	−325	−0.0018	−0″.03
247	− .0345	0.7	+ .869	−320	+ .0028	+ .05
393	− .0460	0.7	+ .576	−293	− .0009	− .01
410	− .0466	0.9	+ .463	−285	+ .0012	+ .02
439	− .0504	1.0	+ .292	−274	+ .0013	+ .03
675	− .0669	0.7	− .458	−228	+ .0016	+ .03
730	− .0767	0.8	− .661	−213	− .0033	− .06
848	− .0841	0.7	− .951	−174	− .0014	− .02
884	− .0834	0.7	− .957	−170	− .0001	.00
891	− .0834	1.0	− .956	−163	+ .0008	+ .02
1637	− .0850	0.8	+ .906	+ 40	− .0014	− .02
1638	− .0856	0.8	+ .906	+ 40	− .0020	− .03
1701	− .0860	1.0	+ .863	+ 46	− .0010	− .02
1702	− .0864	0.7	+ .863	+ 46	− .0014	− .02
1714	− .0850	1.0	+ .847	+ 48	+ .0005	+ .01
1715	− .0836	1.0	+ .847	+ 48	+ .0019	+ .04
3597	− .1742	0.9	− .863	+538	− .0002	.00
3598	− .1716	0.8	− .863	+538	+ .0024	+ .04
3628	− .1776	0.8	− .918	+547	− .0016	− .03
3629	−0.1752	0.8	−0.918	+547	+0.0008	+0.01

The normal equations are:

$$16.3c + 1.721\mu + 0.7060\pi = -1.5044 \text{ mm.}$$
$$+ 145.4996\mu - 14.7314\pi = -2.2627 \text{ mm.}$$
$$+ 10.7609\pi = +0.2828 \text{ mm.}$$

from which:

$c = -0.09155$ mm.

$\mu = -0.01300$ mm. $= -0''.2704$, or $-0''.986$ per year.

$\pi = +0.01448$ mm. $= +\mathbf{0''.302 \pm 0''.007}$.

Probable error of plate of unit weight

± 0.00105 mm. $= \pm 0''.022$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−44.6	+53.2	+0.184
2	.14	−45.4	+14.4	.174
3	.14	+ 9.5	−39.1	.156
4	.12	+22.9	−20.0	.160
5	.16	+23.1	+21.0	.170
6	.14	+34.5	−29.5	+0.156
Parallax star	+0.16	− 1.7	+ 1.9	

10 TAURI ($3^h\ 31^m$; $+0°\ 5'$)

This star of magnitude 4.40, of type G5, and of total proper motion $0''.536$. Its parallax has been three times published; the Yale heliometer by Chase gave $+0''.057 \pm 0''.039$, the meridian circle by Jewdokimov gave $+0''.095 \pm 0''.104$, and the spectrographic value of Adams is $+0''.100$. Mr. Mitchell measured the McCormick plates, and found a relative of $+0''.043 \pm 0''.006$, with a proper motion in right ascension $-0''.260$ while the corresponding value from Boss is $-0''.234$. The same series of plates was used for the star Σ 422.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−54.0	+34.6	+0.189
2	.10	−16.6	−17.5	.232
3	.10	+ 0.4	−14.6	.218
4	.15	+30.3	−19.8	.207
5	.12	+39.9	+17.3	+0.154
Parallax star	0.18	− 1.6	− 2.1	

TABLE 1

PLATES OF 10 TAURI

No.	Date.	Hour Angle.	Observers.	Weight.
1749	1915 Sept. 23	$-0^h.4$	M	0.7
1770	Oct. 2	−0.3	M	0.7
1771	Oct. 2	+0.1	M	0.7
2252	1916 Jan. 2	−0.3	M	0.4*
2319	Jan. 14	+0.2	Ol	0.6
2320	Jan. 14	+0.7	Ol	0.6
2359	Feb. 3	−0.1	M, A	0.6
2988	Sept. 9	−0.5	M	0.7
3146	Oct. 7	−1.2	M	0.8
3642	1917 Feb. 6	−0.3	M	0.8
3643	Feb. 6	+0.2	M, L	0.8
3665	Feb. 14	+0.6	M	0.7
3668	Feb. 16	+0.7	Ol	0.6
4384	Sept. 1	−1.2	B	0.7
4477	Sept. 26	+0.8	B	0.6
4524	Oct. 6	−0.9	M	1.0
4525	Oct. 6	−0.6	M	0.7
5113	1918 Feb. 21	+1.3	A	0.9
5157	Mar. 3	+2.1	M	0.7
5701	Sept. 21	−0.1	M	0.7
5702	Sept. 21	+0.3	M	1.0
5713	Sept. 22	+0.2	M	1.0
5714	Sept. 22	+0.6	M	1.0
6103	Dec. 18	−0.3	M	1.0
6104	Dec. 18	+0.1	M	0.9
6230	1919 Jan. 12	−0.4	M	0.9
6231	Jan. 12	+0.1	M	1.0

* One exposure.

The normal equations are:

$$20.8c + 15.156\mu - 0.5881\pi = -0.8857 \text{ mm.}$$
$$+ 371.2914\mu - 1.4959\pi = -1.8805 \text{ mm.}$$
$$+ 13.3964\pi = +0.0564 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR 10 TAURI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1749	−0.0141	0.7	+0.801	−624	−0.0029	−0″.05
1770	− .0165	0.7	+ .705	−615	− .0010	− .02
1771	− .0204	0.7	+ .705	−615	+ .0029	+ .05
2252	− .0236	0.4	− .685	−523	.0000	.00
2319	− .0263	0.6	− .811	−511	+ .0021	+ .03
2320	− .0274	0.6	− .811	−511	+ .0032	+ .05
2359	− .0222	0.6	− .938	−491	− .0030	− .05
2988	− .0282	0.7	+ .908	−272	− .0006	− .01
3146	− .0286	0.8	+ .635	−244	− .0018	− .03
3642	− .0408	0.8	− .949	−122	+ .0030	+ .06
3643	− .0376	0.8	− .949	−122	− .0002	.00
3665	− .0388	0.7	− .959	−114	+ .0007	+ .01
3668	− .0379	0.6	− .959	−112	− .0003	.00
4384	− .0418	0.7	+ .952	+ 85	+ .0008	+ .01
4477	− .0390	0.6	+ .765	+110	− .0032	− .05
4524	− .0425	1.0	+ .651	+120	− .0003	− .01
4525	− .0431	0.7	+ .651	+120	+ .0003	+ .01
5113	− .0505	0.9	− .953	+258	− .0003	− .01
5157	− .0486	0.7	− .920	+268	− .0025	− .04
5701	− .0526	0.7	+ .817	+470	− .0018	− .03
5702	− .0562	1.0	+ .817	+470	+ .0018	+ .04
5713	− .0558	1.0	+ .808	+471	+ .0013	+ .03
5714	− .0566	1.0	+ .808	+471	+ .0021	+ .04
6103	− .0588	1.0	− .490	+558	− .0013	− .03
6104	− .0610	0.9	− .490	+558	+ .0009	+ .02
6230	− .0592	0.9	− .794	+583	− .0024	− .05
6231	−0.0626	1.0	−0.794	+583	+0.0010	+0.02

from which:

$c = -0.04003$ mm.

$\mu = -0.00342$ mm. $= -0''.0712$ or $-0''.260$ per year.

$\pi = +0.00207$ mm. $= +$ **0″.043 ± 0″.006.**

Probable error of plate of unit weight

± 0.00114 mm. $= \pm 0''.024$.

Σ 422 ($3^h\ 31^m$; $+0°\ 15'$)

This double star of magnitudes 6.0 and 8.2 is a system of the 61 *Cygni* type of common proper motion amounting to 0″.151 per year. The only determination of its parallax is the

TABLE 1

PLATES OF Σ 422

No.	Date.	Hour Angle.	Observers.	Weight.
1749	1915 Sept. 23	−0ʰ.4	M	0.7
1770	Oct. 2	−0.3	M	0.7
1771	Oct. 2	+0.1	M	0.7
2252	1916 Jan. 2	−0.3	M	0.4*
2319	Jan. 14	+0.2	Ol	0.6
2359	Feb. 3	−0.1	M, A	0.6
2988	Sept. 9	−0.5	M	0.7
3070	Sept. 23	−0.9	M	0.4*
3146	Oct. 7	−1.2	M	0.8
3642	1917 Feb. 6	−0.3	M	0.8
3643	Feb. 6	+0.2	M, L	0.8
3665	Feb. 14	+0.6	M	0.7
3668	Feb. 16	+0.7	Ol	0.6
4384	Sept. 1	−1.2	B	0.7
4477	Sept. 26	+0.8	B	0.6
4524	Oct. 6	−0.9	M	1.0
4525	Oct. 6	−0.6	M	0.7
5157	1918 Mar. 3	+2.1	M	0.7
5701	Sept. 21	−0.1	M	0.7
5702	Sept. 21	+0.3	M	1.0
5713	Sept. 22	+0.2	M	1.0
5714	Sept. 22	+0.6	M	1.0
6103	Dec. 18	−0.3	M	1.0
6104	Dec. 18	+0.1	M	0.9
6230	1919 Jan. 12	−0.4	M	0.9
6231	Jan. 12	+0.1	M	1.0

* One exposure.

spectroscopic value + 0″.052. The rotating sector was used, and as a consequence the fainter star did not appear. Mr. Mitchell measured the plates and found a relative parallax of + 0″.007 ± 0″.007 with a proper motion in right ascension − 0″.077 while the corresponding value from Boss is − 0″.021. The same plates were used for the star 10 Tauri.

TABLE 2

REDUCTIONS FOR Σ 422

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1749	+0.0535	0.7	+0.801	−624	−0.0017	−0″.03
1770	+ .0521	0.7	+ .705	−615	− .0004	− .01
1771	+ .0502	0.7	+ .705	−615	+ .0015	+ .03
2252	+ .0537	0.4	− .685	−523	− .0034	− .05
2319	+ .0502	0.6	− .811	−511	− .0001	.00
2359	+ .0520	0.6	− .938	−491	− .0021	− .03
2988	+ .0472	0.7	+ .908	−272	+ .0011	+ .02
3070	+ .0499	0.4	+ .794	−259	− .0018	− .02
3146	+ .0450	0.8	+ .635	−244	+ .0029	+ .05
3642	+ .0432	0.8	− .949	−122	+ .0029	+ .05
3643	+ .0438	0.8	− .949	−122	+ .0023	+ .04
3665	+ .0483	0.7	− .959	−114	− .0023	− .04
3668	+ .0472	0.6	− .959	−112	− .0012	− .02
4384	+ .0448	0.7	+ .952	+ 85	− .0002	.00
4477	+ .0456	0.6	+ .765	+110	− .0013	− .02
4524	+ .0440	1.0	+ .651	+120	+ .0002	.00
4525	+ .0449	0.7	+ .651	+120	− .0007	− .01
5157	+ .0390	0.7	− .920	+268	+ .0032	+ .05
5701	+ .0399	0.7	+ .817	+470	+ .0008	+ .01
5702	+ .0412	1.0	+ .817	+470	− .0005	− .01
5713	+ .0403	1.0	+ .808	+471	+ .0004	+ .01
5714	+ .0410	1.0	+ .808	+471	− .0003	− .01
6103	+ .0421	1.0	− .490	+558	− .0027	− .06
6104	+ .0382	0.9	− .490	+558	+ .0012	+ .02
6230	+ .0414	0.9	− .794	+583	− .0024	− .05
6231	+0.0374	1.0	−0.794	+583	+0.0016	+0.03

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−47.8	+ 8.1	+0.349
3	.10	+ 6.6	−41.1	.296
6	.12	+41.2	+33.0	+0.355
Parallax star	0.14	− 0.1	+ 2.3	

The normal equations are:

$$19.7c + 14.864\mu + 1.0738\pi = + 0.8756 \text{ mm.}$$
$$+ 352.3166\mu - 2.5922\pi = + 0.3122 \text{ mm.}$$
$$+ 12.4366\pi = + 0.0553 \text{ mm.}$$

from which:

$c = + 0.04520$ mm.
$\mu = - 0.00102$ mm. $= - 0''.0212$, or $- 0''.077$ per year.
$\pi = + 0.00034$ mm. $= + \mathbf{0''.007 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00110 \text{ mm.} = \pm 0''.023.$$

W. B. 3^h 617 (3^h 35^m; $-3°$ 32′)

This is a star of 7.2 magnitude, and F8 type, with a considerable proper motion of 0″.79, and also a large radial velocity of + 114 km. per second, (Adams, *Astrophysical Journal*, **42**, 172, 1915.) Two values of the parallax have been found, Smith with the Yale heliometer deriving the value − 0″.080 ± 0″.015, and Adams by the spectrograph the result + 0″.035. Mr. Alden measured the McCormick series of plates, and found the parallax + 0″.021 ± 0″.008, and the proper motion in right ascension of + 0″.682 per year, the corresponding value derived by Porter is + 0″.713.

TABLE 1

PLATES OF W. B. 3^h 617

No.	Date.	Hour Angle.	Observers.	Weight.
1793	1915 Oct. 9	-0^h9	M	0.6
3028	1916 Sept. 18	0.0	L	0.8
3085	Sept. 24	+0.1	L	0.9
3646	1917 Feb. 7	−0.1	Ol	1.0
3653	Feb. 12	+0.4	Ol	0.9
3654	Feb. 12	+1.1	A	1.0
4428	Sept. 12	0.0	A	1.0
4429	Sept. 12	+0.5	A	1.0
4506	Oct. 2	+0.6	A	0.9
4517	Oct. 5	−0.7	A	1.0
4518	Oct. 5	−0.2	A	1.0
4925	1918 Jan. 10	+0.4	A	0.9
5091	Feb. 14	+0.6	A	0.9
5133	Feb. 26	+1.7	Ol	0.8
5152	Mar. 2	+1.9	M	0.8

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−81.4	−13.9	+0.2274
2	.14	+14.9	+34.0	.2433
3	.12	+16.0	+12.9	.2509
4	.13	+50.5	−33.0	+0.2784
Parallax star	0.16	+ 3.2	− 0.8	

TABLE 2

REDUCTIONS FOR W. B. 3^h 617

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1793	+0.0038	0.6	+0.631	−612	−0.0011	−0″.02
3028	+ .0332	0.8	+ .848	−267	+ .0007	+ .01
3085	+ .0352	0.9	+ .793	−261	− .0008	− .02
3646	+ .0464	1.0	− .950	−125	− .0016	− .03
3653	+ .0424	0.9	− .959	−120	+ .0028	+ .06
3654	+ .0447	1.0	− .959	−120	+ .0006	+ .01
4428	+ .0669	1.0	+ .896	+ 92	− .0007	− .01
4429	+ .0661	1.0	+ .896	+ 92	+ .0001	.00
4506	+ .0656	0.9	+ .709	+112	+ .0022	+ .04
4517	+ .0710	1.0	+ .674	+115	− .0030	− .06
4518	+ .0656	1.0	+ .674	+115	+ .0024	+ .05
4925	+ .0757	0.9	− .770	+212	− .0004	− .01
5091	+ .0790	0.9	− .960	+247	− .0008	− .01
5133	+ .0793	0.8	− .945	+259	.0000	.00
5152	+0.0804	0.8	−0.930	+263	−0.0007	−0.01

The normal equations are:

$$13.5c + 1.768\mu - 0.2803\pi = + 0.7854 \text{ mm.}$$
$$+ 64.5077\mu - 6.2216\pi = + 0.6741 \text{ mm.}$$
$$+ 9.7660\pi = - 0.0618 \text{ mm.}$$

from which:

$c = + 0.05702$ mm.

$\mu = + 0.00899$ mm. $= + 0''.1869$, or $+ 0''.682$ per year.

$\pi = + 0.00103$ mm. $= +$ **0″.021 ± 0″.008.**

Probable error of plate of unit weight

$$\pm 0.00111 \text{ mm.} = \pm 0''.023.$$

ν PERSEI (3^h 38^m; $+42°$ 16′)

This star of 3.93 magnitude and of type F5 has a small proper motion 0″.009. The only parallax so far published is the spectroscopic result of Adams who finds the absolute parallax + 0″.016. Mr. Olivier measured the McCormick plates, and derived a relative parallax of + 0″.028 ± 0″.012, with a proper motion in

right ascension of + 0″.029, while the corresponding value from Boss is − 0″.009.

TABLE 1

PLATES OF ν PERSEI

No.	Date.	Hour Angle.	Observers.	Weight.
1618	1915 Sept. 7	−0h1	Ol	0.8
1832	Oct. 22	−0.6	G	0.9
1859	Oct. 25	−0.2	Ol	0.8
2267	1916 Jan. 3	−1.1	G	0.7
2287	Jan. 4	−0.4	Ol	0.8
3059	Sept. 22	−0.5	Ol	0.4*
3060	Sept. 22	−1.1	Ol	0.4*
3184	Oct. 12	−0.8	L	0.7
3220	Oct. 20	−0.4	L	0.7
3309	Oct. 30	0.0	Ol	0.7
3552	1917 Jan. 2	−0.3	M	0.9
3553	Jan. 2	0.0	M	0.7
3618	Jan. 26	−0.4	L, Ol	1.0
3619	Jan. 26	−0.1	L	0.8
4402	Sept. 10	−0.2	B	0.7
4414	Sept. 11	−1.2	Ol	0.5*
4415	Sept. 11	−0.4	Ol	0.9
4467	Sept. 24	−0.3	B	0.9
4476	Sept. 26	−0.1	B	0.9
4908	Dec. 26	−0.5	B	0.9
4909	Dec. 26	−0.1	B	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−45.1	− 8.6	+0.1735
2	.12	−26.0	+ 1.1	.1922
3	.08	−25.2	+31.9	.2311
4	.10	+49.1	−36.7	.1713
5	.11	+47.2	+12.3	+0.2319
Parallax star	0.12	+ 0.7	+ 2.6	

TABLE 2

REDUCTIONS FOR ν PERSEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1618	−0.0032	0.8	+0.935	−461	+0.0021	+0″.04
1832	+ .0034	0.9	+ .461	−416	− .0049	− .10
1859	− .0044	0.8	+ .415	−413	+ .0028	+ .05
2267	− .0038	0.7	− .679	−343	+ .0011	+ .02
2287	− .0021	0.8	− .691	−342	− .0006	− .01
3059	+ .0014	0.4	+ .821	− 80	− .0012	− .01
3060	− .0021	0.4	+ .821	− 80	+ .0024	+ .03
3184	+ .0026	0.7	+ .592	− 60	− .0026	− .05
3220	− .0058	0.7	+ .479	− 52	+ .0057	+ .10
3309	+ .0045	0.7	+ .325	− 42	− .0048	− .08
3552	− .0022	0.9	− .677	+ 22	+ .0009	+ .02
3553	− .0014	0.7	− .677	+ 22	+ .0001	.00
3618	− .0002	1.0	− .897	+ 46	− .0013	− .03
3619	− .0034	0.8	− .897	+ 46	+ .0019	+ .04
4402	+ .0028	0.7	+ .915	+273	− .0011	− .02
4414	+ .0045	0.5	+ .909	+274	− .0028	− .04
4415	+ .0006	0.9	+ .909	+274	+ .0011	+ .02
4467	− .0007	0.9	+ .804	+287	+ .0024	+ .05
4476	+ .0026	0.9	+ .784	+289	− .0010	− .02
4908	− .0018	0.9	− .584	+380	+ .0020	+ .04
4909	+0.0025	0.9	−0.584	+380	−0.0023	−0.05

The normal equations are:

$$16.0c + 1.360\mu + 1.6941\pi = -0.0055 \text{ mm.}$$
$$+ 121.9996\mu + 0.3073\pi = +0.0467 \text{ mm.}$$
$$+ 8.4256\pi = +0.0104 \text{ mm.}$$

from which:

$c = -0.00052$ mm.

$\mu = +0.00039$ mm. $= +0''.0080$, or $\pm 0''.029$ per year.

$\pi = +0.00132$ mm. $= +\mathbf{0''.028 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00162 \text{ mm.} = \pm 0''.034.$$

δ ERIDANI ($3^h\ 38^m$; $-10°\ 6'$)

Like ε Eridani, this star has a large proper motion amounting to 0″.75 per year, and it is of type K. Its magnitude is 3.72. Two trigonometric parallaxes have been found: + 0″.086 ± 0″.034 by Flint with the meridian circle, and + 0″.181 ± 0″.015 by Smith with the heliometer. The spectroscopic parallax of

TABLE 1

PLATES OF δ ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
275	1914 Sept. 20	$-0^h.5$	M, A	0.7
307	Sept. 23	+0.6	A	0.7
453	Oct. 31	+0.4	M	0.8
482	Nov. 3	+0.2	G	0.7
746	1915 Jan. 7	−0.6	G, Ol	0.7
817	Jan. 21	−0.5	G	0.9
818	Jan. 21	+0.1	G	0.9
850	Feb. 8	−0.6	G	0.8
1708	Sept. 16	−1.0	Ol	0.5*
1709	Sept. 16	−0.3	Ol	0.8
1727	Sept. 21	−0.7	G	0.4*
1728	Sept. 21	−0.1	G	0.5
1794	Oct. 9	−0.1	M	0.8
1831	Oct. 15	−0.4	M	0.9
3581	1917 Jan. 14	+0.7	M	0.8
3582	Jan. 14	+1.1	M	0.8
3599	Jan. 19	+0.3	Ol	1.0
3600	Jan. 19	+0.8	Ol	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination):	Dependence.
	mm.	mm.	mm.	
1	0.20	−47.0	− 8.8	+0.2129
2	.13	−44.5	+ 7.1	.2053
3	.29	+21.1	+27.9	.1833
4	.14	+33.5	+29.5	.1802
5	.16	+36.9	−55.7	+0.2183
Parallax star	0.18	− 1.2	− 2.1	

Adams is + 0″.082. The eighteen plates of the series were measured by Mr. Mitchell, who finds the proper motion in right ascension to be − 0″.083 per year, while Boss gives the value − 0″.093.

TABLE 2

REDUCTIONS FOR δ ERIDANI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
275	+0.0188	0.7	+0.843	−347	+0.0023	+0″.04
307	+ .0215	0.7	+ .816	−344	− .0006	− .01
453	+ .0212	0.8	+ .317	−306	− .0039	− .07
482	+ .0156	0.7	+ .269	−303	+ .0013	+ .02
746	+ .0099	0.7	− .728	−238	− .0001	.00
817	+ .0077	0.9	− .859	−224	+ .0011	+ .02
818	+ .0064	0.9	− .859	−224	+ .0024	+ .05
850	+ .0105	0.8	− .951	−206	− .0025	− .04
1708	+ .0161	0.5	+ .877	+ 14	+ .0013	+ .02
1709	+ .0173	0.8	+ .877	+ 14	+ .0001	.00
1727	+ .0157	0.4	+ .836	+ 19	+ .0014	+ .02
1728	+ .0135	0.5	+ .836	+ 19	+ .0036	+ .05
1794	+ .0160	0.8	+ .641	+ 37	− .0004	− .01
1831	+ .0184	0.9	+ .561	+ 53	− .0035	− .07
3581	+ .0034	0.8	− .805	+500	− .0022	− .04
3582	− .0025	0.8	− .805	+500	+ .0038	+ .07
3599	+ .0022	1.0	− .848	+505	− .0013	− .03
3600	+0.0006	1.0	−0.848	+505	+0.0003	+0.01

The normal equations are:

$$13.7c + 2.474\mu - 1.2872\pi = + 0.1519 \text{ mm.}$$
$$+ 138.4466\mu - 13.3605\pi = - 0.2079 \text{ mm.}$$
$$+ 8.2332\pi = + 0.0524 \text{ mm.}$$

from which:

$c = + 0.01189$ mm.

$\mu = - 0.00109$ mm. $= - 0''.0227$, or $- 0''.083$ per year.

$\pi = + 0.00645$ mm. $= + \mathbf{0''.134} \pm \mathbf{0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

LALANDE 6888–6889 (3^h 40^m; $+41°$ 9′)

These stars form the double Σ 443. They are of unusual interest due to their very large common proper motion of 1″.38 per year. The magnitudes are 8.2 and 8.8. These stars were placed on the McCormick observing program for the reason that the early parallax determinations show large discordances, the parallax values ranging all the way from − 0″.14 to + 0″.23. The individual measures are as follows:

Lal. 6888.	Lal. 6889.	Authority.	Method.
−0″.14 ±0″.040		Flint	Meridian Circle
+0.035± .034		Chase	Heliometer
+0.068± .020	+0″.046±0″.020	Kostinsky and von Zeipel	Photography
+0.228± .090		Jewdokimov	Meridian Circle
+0.029± .033	+0.020± .034	Russell	Photography
−0.016±0.011	+0.010±0.008	Slocum and Mitchell	Photography

In order that the McCormick results might be directly comparable with the results from the use of the 40-inch refractor, the same set of comparison stars were utilized as were employed by Slocum and Mitchell (*Publications of Yerkes Observatory*, 4, 9, 1917). The comparison of the two results is especially interesting as giving a ready means of deriving a more accurate value of the proper motion than could be obtained from the measures already made at either telescope alone. The determination of the proper motion increases in accuracy as the time is increased, and the combination of Yerkes and McCormick is separated by a greater interval than is found in either the Yerkes or the McCormick measures. In spite of the difference in scale of the Yerkes and McCormick photographs, it is readily possible to compare their results by employing for the McCormick measures the same dependences as were utilized at Yerkes. When this is done, both sets of measures may be turned into seconds of arc by multiplying by their respective scale values. If the first six plates taken at Yerkes (*loc. cit.*), are compared

with the last eight McCormick plates, it is readily seen that the parallax is eliminated. The interval separating the Yerkes and McCormick plates is 2625 days. In this interval, the proper motion of Lalande 6888 is + 4″.341, and of Lalande 6889, + 4″.384, respectively, corresponding to annual proper motions of + 0″.603 and + 0″.609, respectively. The mean of these results gives a proper motion in right ascension of + 0″.606 per year. This, however, is the motion referred to the mean of the four comparison stars which were used. If any of the four has motion of its own, this motion will, of course, show its effect. Since also these comparison stars are at a finite distance away from us, they must show the results of the solar drift. This drift will amount approximately to + 0″.009 in right ascension per year. The proper motion of Lalande 6888 is given by Boss as amounting to + 0″.599 per year. If we correct the value of the proper motion found from the comparison of the Yerkes and McCormick photographs by the amount depending on the solar drift, then there results a proper motion in right ascension of + 0″.615 per year, which is greater than Boss's value by + 0″.016. The proper motions found from the Yerkes and McCormick plates separately are:

	Lalande 6888.	Lalande 6889.
Yerkes	+0″.580	+0″.598
McCormick	+0.629	+0.631
Mean	+0″.604	+0″.614

The McCormick photographs which were measured by Mr. Mitchell give the parallax of the system Lalande 6888–9 to be **+ 0″.025 ± 0″.007.**

TABLE 1

PLATES OF LALANDE 6888–9

No.	Date.	Hour Angle.	Observers.	Weight.
3232	1916 Oct. 21	$-0^h.5$	M	0.8
3259	Oct. 24	−0.4	M	0.9
3260	Oct. 24	−0.1	M	0.8
3579	1917 Jan. 14	−0.3	M	1.0
3626	Jan. 28	−0.5	M	0.9
3627	Jan. 28	−0.3	M	1.0
4354	Aug. 26	−0.9	A	1.0
4450	Sept. 19	−0.7	A	1.0
4451	Sept. 19	−0.4	A	1.0
4504	Oct. 2	−0.4	A	1.0
4505	Oct. 2	0.0	A	1.0
4957	1918 Jan. 20	−0.4	M	0.8
4958	Jan. 20	−0.1	M	0.8
5009	Jan. 31	−0.2	A	1.0
5033	Feb. 9	−0.2	M	0.8
5689	Sept. 14	−0.6	M	0.8
5690	Sept. 14	−0.2	M	0.8
5710	Sept. 22	−1.0	M	1.0
5712	Sept. 22	−0.6	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				Lat. 6888.	Lat. 6889.
	mm.	mm.	mm.		
1	0.13	−44.9	+ 6.5	+0.276	+0.272
2	.11	−18.0	+13.0	.199	.208
3	.10	+12.2	−16.4	.329	.316
4	.12	+50.7	− 3.1	+0.196	+0.204
Lal. 6888	.22	− 2.1	− 1.6		
Lal. 6889	0.18	− 1.8	− 1.4		

TABLE 2

REDUCTIONS FOR LALANDE 6888

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3232	−0.0344	0.8	+0.469	−347	+0.0006	+0″.01
3259	− .0327	0.9	+ .424	−344	− .0010	− .02
3260	− .0360	0.8	+ .424	−344	+ .0023	+ .04
3579	− .0274	1.0	− .802	−262	− .0007	− .01
3626	− .0250	0.9	− .907	−248	− .0021	− .04
3627	− .0304	1.0	− .907	−248	+ .0033	+ .07
4354	− .0083	1.0	+ .978	− 38	+ .0006	+ .01
4450	− .0031	1.0	+ .853	− 14	− .0028	− .06
4451	− .0039	1.0	+ .853	− 14	− .0020	− .04
4504	− .0082	1.0	+ .723	− 1	+ .0033	+ .07
4505	− .0026	1.0	+ .723	− 1	− .0023	− .05
4957	+ .0022	0.8	− .852	+109	+ .0004	+ .01
4958	+ .0024	0.8	− .852	+109	+ .0002	.00
5009	+ .0041	1.0	− .922	+120	− .0007	− .01
5033	+ .0052	0.8	− .954	+129	− .0011	− .02
5689	+ .0272	0.8	+ .893	+346	− .0032	− .06
5690	+ .0229	0.8	+ .893	+346	+ .0011	+ .02
5710	+ .0219	1.0	+ .829	+354	+ .0027	+ .06
5712	+0.0236	1.0	+0.829	+354	+0.0010	+0.02

The normal equations are:

$$17.4c + 0.044\mu + 2.7391\pi = -0.0946 \text{ mm.}$$
$$+ 97.3738\mu + 9.2047\pi = +0.8171 \text{ mm.}$$
$$+ 11.5350\pi = +0.0731 \text{ mm.}$$

from which:

$c = -0.00558$ mm.

$\mu = +0.00829$ mm. $= +0''.1724$, or $+0''.629$ per year.

$\pi = +0.00105$ mm. $= +$ **0″.022 ± 0″.009.**

Probable error of plate of unit weight

$$\pm 0.00139 \text{ mm.} = \pm 0''.029.$$

TABLE 3

REDUCTIONS FOR LALANDE 6889

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3232	+0.0029	0.8	+0.469	−347	−0.0002	0″.00
3259	+ .0040	0.9	+ .424	−344	− .0011	− .02
3260	+ .0025	0.8	+ .424	−344	+ .0004	+ .01
3579	+ .0103	1.0	− .802	−262	− .0022	− .05
3626	+ .0084	0.9	− .907	−248	+ .0007	+ .01
3627	+ .0095	1.0	− .907	−248	− .0004	− .01
4354	+ .0260	1.0	+ .978	− 38	+ .0031	+ .06
4450	+ .0310	1.0	+ .853	− 14	− .0001	.00
4451	+ .0276	1.0	+ .853	− 14	+ .0033	+ .07
4504	+ .0329	1.0	+ .723	− 1	− .0011	− .02
4505	+ .0339	1.0	+ .723	− 1	− .0021	− .04
4957	+ .0372	0.8	− .852	+109	+ .0016	+ .03
4958	+ .0410	0.8	− .852	+109	− .0022	− .04
5009	+ .0389	1.0	− .922	+120	+ .0008	+ .02
5033	+ .0378	0.8	− .954	+129	+ .0026	+ .05
5689	+ .0666	0.8	+ .893	+346	− .0057	− .11
5690	+ .0573	0.8	+ .893	+346	+ .0036	+ .07
5710	+ .0627	1.0	+ .829	+354	− .0013	− .03
5712	+0.0612	1.0	+0.829	+354	+0.0002	0.00

The normal equations are:

$$17.4c - 0.044\mu + 2.7391\pi = + 0.5414 \text{ mm.}$$
$$+ 97.3738\mu + 9.2047\pi = + 0.8201 \text{ mm.}$$
$$+ 11.5350\pi = + 0.1767 \text{ mm.}$$

from which:

$c = + 0.03092$ mm.

$\mu = + 0.00831$ mm. $= + 0''.1728$, or $0''.631$ per year.

$\pi = + 0.00134$ mm. $= + \mathbf{0''.028 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00153 \text{ mm.} = \pm 0''.032.$$

τ^6 ERIDANI (3^h 42^m; $-23°$ 32′)

This is a star of magnitude 4.33, of spectral type F8 and of total proper motion 0″.548. Mr. Mitchell measured fifteen plates of the present series, the earlier plates being measured by Mr. Briggs and partially by Mr. Lamb. A relative parallax + 0″.068 ± 0″.010 resulted and a proper motion in right ascension − 0″.162 per year whereas the corresponding value from Boss is − 0″.163.

TABLE 1

PLATES OF τ^6 ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
3099	1916 Sept. 26	−0^h.3	L	0.6
3128	Oct. 1	−0.6	L	1.0
3129	Oct. 1	−0.2	L	1.0
3288	Oct. 27	−0.2	M	1.0
3637	1917 Jan. 30	−0.4	L	0.8
3638	Jan. 30	0.0	L	1.0
4452	Sept. 19	+0.2	A	1.0
4492	Oct. 1	−0.2	B	0.9
4493	Oct. 1	+0.2	B	0.9
4910	Dec. 26	+0.4	B	0.6*
4911	Dec. 26	+0.8	B	0.8
5826	1918 Oct. 21	+0.2	M	0.7
5827	Oct. 21	+0.6	M	0.6
6449	1919 Feb. 2	+0.7	M	0.8
6450	Feb. 2	+1.1	M	1.0
6471	Feb. 5	−0.4	D	1.0
6472	Feb. 5	+0.1	D	1.0
7653	Sept. 6	−0.9	M	0.7
7654	Sept. 6	−0.4	M	1.0
7705	Sept. 13	−0.9	M	1.0
7706	Sept. 13	−0.4	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR τ^6 ERIDANI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3099	+0.0218	0.6	+0.792	−551	+0.0015	+0″.02
3128	+ .0189	1.0	+ .740	−546	+ .0042	+ .09
3129	+ .0237	1.0	+ .740	−546	− .0006	− .01
3288	+ .0229	1.0	+ .387	−520	− .0016	− .03
3637	+ .0133	0.8	− .916	−425	+ .0017	+ .03
3638	+ .0154	1.0	− .916	−425	− .0004	− .01
4452	+ .0178	1.0	+ .858	−193	− .0019	− .04
4492	+ .0182	0.9	+ .742	−181	− .0029	− .06
4493	+ .0180	0.9	+ .742	−181	− .0027	− .05
4910	+ .0067	0.6	− .573	− 95	+ .0024	+ .04
4911	+ .0108	0.8	− .573	− 95	− .0017	− .03
5826	+ .0052	0.7	+ .485	+204	+ .0010	+ .02
5827	+ .0018	0.6	+ .485	+204	+ .0044	+ .07
6449	− .0028	0.8	− .928	+308	+ .0022	+ .04
6450	+ .0002	1.0	− .928	+308	− .0008	− .02
6471	− .0022	1.0	− .940	+311	+ .0015	+ .03
6472	+ .0028	1.0	− .940	+311	− .0035	− .07
7653	− .0039	0.7	+ .946	+524	+ .0048	+ .08
7654	+ .0003	1.0	+ .946	+524	+ .0006	+ .01
7705	+ .0036	1.0	+ .906	+531	− .0030	− .06
7706	+0.0008	1.0	+0.906	+531	−0.0002	0.00

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−42.9	−14.2	+0.343
2	.24	−27.7	+22.9	.153
3	.10	− 0.5	+ 2.8	.237
4	.10	+71.1	−11.5	+0.267
Parallax star	0.16	− 0.06	− 3.76	

The normal equations are:

$$18.4c + 0.350\mu + 2.5851\pi = + 0.1729 \text{ mm.}$$
$$+ 293.1771\mu - 0.6722\pi = - 0.6239 \text{ mm.}$$
$$+ 12.1046\pi = + 0.0644 \text{ mm.}$$

from which:

$c = + 0.00898$ mm.
$\mu = - 0.00213$ mm. $= - 0''.0443$, or $- 0''.162$ per year.
$\pi = + 0.00328$ mm. $= + \mathbf{0''.068 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00163 \text{ mm.} = \pm 0''.034.$$

32 ERIDANI ($3^h\ 49^m$; $-3°\ 15'$)

The brighter star of this double Σ 470 is of magnitude 4.95 and spectral type G_p, and the fainter of magnitude 6.33 and A. They have a common proper motion $0''.035$, and show no orbital motion. The distance separating them is $6''.7$. Miss France measured the plates finding the proper motions for the brighter and fainter stars to be $+ 0''.031$ and $+ 0''.032$, respectively, where the corresponding value from Boss is $+ 0''.034$. Small relative parallaxes $+ 0''.008 \pm 0''.010$ and $- 0''.009 \pm 0''.009$ for brighter and fainter stars resulted.

TABLE 1

PLATES OF 32 ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
3147	1916 Oct. 7	−0h9	M	1.0
4519	1917 Oct. 5	+0.3	A	1.0
4520	Oct. 5	+0.7	A	1.0
4542	Oct. 7	−0.7	Ol	0.8
4543	Oct. 7	−0.3	Ol	0.9
6171	1919 Jan. 4	0.0	M	1.0
6197	Jan. 8	−0.7	F	1.0
6360	Jan. 27	−0.3	D	1.0
6361	Jan. 27	+0.2	D	0.9
7614	Sept. 2	−0.7	F	0.9
7615	Sept. 2	−0.3	F	1.0
7629	Sept. 3	−0.2	H	1.0
7714	Sept. 14	0.0	Ol	0.9
7715	Sept. 14	+0.2	Ol	0.7*
8361	Dec. 30	−0.7	F	0.9
8362	Dec. 30	−0.3	F	0.7*
8633	1920 Feb. 26	+1.0	A	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				Bt.	Ft.
	mm.	mm.	mm.		
1	0.08	−60.2	+11.3	+0.325	+0.320
2	.12	− 0.6	+ 4.8	.221	.224
3	.10	+ 3.5	+16.3	.140	.149
4	.13	+57.3	−32.4	+0.314	+0.307
Brighter star	.18	− 1.3	− 3.1		
Fainter star	0.11	− 1.3	− 2.8		

TABLE 2

REDUCTIONS FOR 32 ERIDANI, BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3147	−0.0153	1.0	+0.691	−806	−0.0008	−0″.02
4519	− .0160	1.0	+ .717	−443	+ .0013	+ .03
4520	− .0146	1.0	+ .717	−443	− .0001	.00
4542	− .0160	0.8	+ .694	−441	+ .0013	+ .02
4543	− .0128	0.9	+ .694	−441	− .0019	− .04
6171	− .0082	1.0	− .666	+ 13	− .0051	− .11
6197	− .0150	1.0	− .714	+ 17	+ .0017	+ .04
6360	− .0166	1.0	− .887	+ 36	+ .0033	+ .07
6361	− .0148	0.9	− .887	+ 36	+ .0015	+ .03
7614	− .0118	0.9	+ .970	+254	.0000	.00
7615	− .0136	1.0	+ .970	+254	+ .0018	+ .04
7629	− .0117	1.0	+ .967	+255	.0000	.00
7714	− .0111	0.9	+ .912	+266	− .0006	− .01
7715	− .0111	0.7	+ .912	+266	− .0006	− .01
8361	− .0118	0.9	− .600	+373	− .0001	.00
8362	− .0088	0.7	− .600	+373	− .0031	− .05
8633	−0.0122	0.7	−0.959	+431	+0.0004	+0.01

The normal equations are:

$$15.4c - 2.816\mu + 2.8774\pi = -0.2023 \text{ mm.}$$
$$+ 202.9126\mu - 13.3852\pi = +0.1137 \text{ mm.}$$
$$+ 10.0460\pi = -0.0394 \text{ mm.}$$

from which:

$c = -0.01314$ mm.

$\mu = +0.00040$ mm. $= +0''.0084$, or $+0''.031$ per year.

$\pi = +0.00037$ mm. $= +$ **0″.008 ± 0″.010.**

Probable error of plate of unit weight

$$\pm 0.00139 \text{ mm.} = \pm 0''.029.$$

TABLE 3

REDUCTIONS FOR 32 ERIDANI, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3147	−0.0170	1.0	+0.691	−806	−0.0003	−0″.01
4519	− .0162	1.0	+ .717	−443	+ .0004	+ .01
4520	− .0158	1.0	+ .717	−443	.0000	.00
4542	− .0155	0.8	+ .694	−441	− .0003	− .01
4543	− .0148	0.9	+ .694	−441	− .0010	− .02
6171	− .0158	1.0	− .666	+ 13	+ .0025	+ .05
6197	− .0104	1.0	− .714	+ 17	− .0029	− .06
6360	− .0159	1.0	− .887	+ 36	+ .0028	+ .06
6361	− .0133	0.9	− .887	+ 36	+ .0002	.00
7614	− .0144	0.9	+ .970	+254	+ .0014	+ .03
7615	− .0112	1.0	+ .970	+254	− .0018	− .04
7629	− .0122	1.0	+ .967	+255	− .0008	− .02
7714	− .0153	0.9	+ .912	+266	+ .0024	+ .05
7715	− .0135	0.7	+ .912	+266	+ .0006	+ .01
8361	− .0130	0.9	− .600	+373	+ .0012	+ .02
8362	− .0069	0.7	− .600	+373	− .0049	− .09
8633	−0.0107	0.7	−0.959	+431	−0.0007	−0.01

The normal equations are:

$$15.4c - 2.816\mu + 2.8774\pi = -0.2124 \text{ mm.}$$
$$+ 202.9126\mu - 13.3852\pi = +0.1302 \text{ mm.}$$
$$+ 10.0460\pi = -0.0492 \text{ mm.}$$

from which:

$c = -0.01363$ mm.

$\mu = +0.00042$ mm. $= +0''.0088$, or $+0''.032$ per year.

$\pi = -0.00042$ mm. $= \mathbf{-0''.009 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

γ ERIDANI ($3^h\ 53^m$; $-13°\ 47'$)

This is a star of magnitude 3.19, and of K5 type, with a total proper motion of 0″.130. The only value of the parallax is the

spectroscopic result of Adams who finds this to be: + 0″.019. Mr. Alden measured the McCormick series of plates and found a proper motion of + 0″.045 while the result from Boss is + 0″.067.

TABLE 1

PLATES OF γ ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
259	1914 Sept. 15	−0^h.9	Ol, A	0.9
498	Nov. 4	+0.3	M	0.9
523	Nov. 6	+0.8	G	1.0
783	1915 Jan. 13	−0.1	A	1.0
860	Feb. 9	+0.3	M, A	0.9
861	Feb. 9	+0.7	A	1.0
906	Feb. 19	+0.5	M	1.0
1688	Sept. 14	−0.8	A	1.0
1689	Sept. 14	−0.4	A	1.0
1779	Oct. 3	−0.6	A	1.0
1780	Oct. 3	−0.1	A	0.9
3639	1917 Jan. 30	+0.4	L	1.0
3640	Jan. 30	+0.7	M	0.8
3676	Feb. 20	+0.5	M	0.9
3677	Feb. 20	+0.8	L	0.7*
4404	Sept. 10	+0.3	B	0.7
4438	Sept. 18	+0.3	B	0.8
4439	Sept. 18	+0.5	B	0.7
4569	Oct. 13	+0.2	B	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−46.1	+29.7	+0.3088
2	.20	−32.2	−22.6	.3031
3	.16	+78.3	− 7.1	+0.3881
Parallax star	0.20	+ 6.4	− 0.4	

TABLE 2

REDUCTIONS FOR γ ERIDANI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
259	+0.0005	0.9	+0.912	−531	−0.0047	−0″.09
498	− .0002	0.9	+ .311	−481	− .0041	− .08
523	− .0003	1.0	+ .279	−479	− .0040	− .08
783	− .0080	1.0	− .759	−411	+ .0034	+ .07
860	− .0065	0.9	− .949	−384	+ .0019	+ .04
861	− .0042	1.0	− .949	−384	− .0004	− .01
906	− .0059	1.0	− .967	−374	+ .0014	+ .03
1688	− .0052	1.0	+ .920	−167	+ .0032	+ .07
1689	− .0049	1.0	+ .920	−167	+ .0028	+ .06
1779	− .0039	1.0	+ .757	−148	+ .0018	+ .04
1780	− .0049	0.9	+ .757	−148	+ .0028	+ .06
3639	+ .0014	1.0	− .905	+337	− .0016	− .03
3640	+ .0034	0.8	− .905	+337	− .0036	− .07
3676	+ .0008	0.9	− .967	+358	− .0010	− .02
3677	− .0030	0.7	− .967	+358	+ .0028	+ .05
4404	+ .0012	0.7	+ .940	+560	+ .0011	+ .02
4438	+ .0002	0.8	+ .889	+568	+ .0021	+ .04
4439	+ .0048	0.7	+ .889	+568	− .0025	− .04
4569	+0.0049	0.7	+0.631	+593	−0.0026	−0.05

The normal equations are:

$$16.9c - 6.811\mu + 0.3859\pi = -0.0319 \text{ mm.}$$
$$+ 273.6887\mu + 4.2670\pi = +0.1766 \text{ mm.}$$
$$+ 11.9705\pi = +0.0097 \text{ mm.}$$

from which:

$c = -0.00166$ mm.

$\mu = +0.00059$ mm. $= +0''.0124$, or $+0''.045$ per year.

$\pi = +0.00065$ mm. $= +$ **0″.014 ± 0″.012.**

Probable error of plate of unit weight

$$\pm 0.00193 \text{ mm.} = \pm 0''.040.$$

43 TAURI ($4^h\ 3^m$; $+19°\ 20'$)

Grossman with the meridian circle finds a parallax of $+ 0''.108 \pm 0''.041$ for this star, while Adams derives the spectroscopic parallax $+ 0''.013$. It is of G type, of magnitude 5.67, and of small proper motion. The plates were measured by Mr. Alden, who finds the proper motion in right ascension to be $+ 0''.076$ while the value given by Boss is $+ 0''.075$.

TABLE 1

PLATES OF 43 TAURI

No.	Date.	Hour Angle.	Observers.	Weight.
321	1914 Sept. 26	$-0^h.6$	M	0.7
343	Sept. 28	+0.1	G	0.8
361	Sept. 30	−0.6	A	1.0
531	Nov. 9	+0.4	G	1.0
762	1915 Jan. 8	+0.8	G	1.0
885	Feb. 11	+1.1	Ol	0.5*
886	Feb. 17	+0.9	G	0.9
1757	Sept. 24	+0.2	G	0.7*
1758	Sept. 24	+0.5	G	0.8
1806	Oct. 10	−0.7	A	0.7
1807	Oct. 10	−0.1	A	0.6
2360	1916 Feb. 3	0.0	A	0.9
2361	Feb. 3	+0.6	M	0.7
2402	Feb. 14	+0.8	G	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−52.1	− 5.4	+0.1917
2	.14	−13.2	+27.2	.1731
3	.14	+ 6.1	−54.6	.2489
4	.12	+12.7	+17.7	.1878
5	.13	+46.5	+15.1	+0.1985
Parallax star	0.17	+ 0.9	− 3.6	

TABLE 2

REDUCTIONS FOR 43 TAURI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
321	+0.0020	0.7	+0.870	−244	−0.0004	−0″.01
343	− .0025	0.8	+ .831	−242	+ .0040	+ .07
361	+ .0035	1.0	+ .823	−240	− .0019	− .04
531	+ .0033	1.0	+ .270	−200	− .0018	− .04
762	+ .0015	1.0	− .678	−140	− .0003	− .01
885	− .0014	0.5	− .951	−106	+ .0027	+ .04
886	+ .0016	0.9	− .966	−100	− .0002	.00
1757	+ .0043	0.7	+ .868	+119	+ .0009	+ .01
1758	+ .0033	0.8	+ .868	+119	+ .0019	+ .03
1806	+ .0081	0.7	+ .708	+135	− .0029	− .05
1807	+ .0051	0.6	+ .708	+135	+ .0001	.00
2360	+ .0085	0.9	− .913	+251	− .0036	− .07
2361	+ .0016	0.7	− .913	+251	+ .0033	+ .05
2402	+0.0039	0.7	−0.959	+262	+0.0011	+0.02

The normal equations are:

$$\begin{aligned} 11.0c - 1.484\mu + 0.4342\pi &= +0.0343 \text{ mm.} \\ +41.4131\mu - 5.9208\pi &= +0.0313 \text{ mm.} \\ +7.3435\pi &= +0.0020 \text{ mm.} \end{aligned}$$

from which:

$c = +0.00322$ mm.

$\mu = +0.00100$ mm. $= +0''.0208$, or $+0''.076$ per year.

$\pi = +0.00089$ mm. $= +$ **0″.019 ± 0″.012.**

Probable error of plate of unit weight

$$\pm 0.00149 \text{ mm.} = \pm 0''.031.$$

o^2 40 ERIDANI ($4^h\ 10^m$; $-7°\ 48'$)

This is an interesting triple system. The brightest star of the system is of G5 type, and of magnitude 4.48. At a distance of 82″, there is a binary system BC of magnitudes 9.4 and 10.8

respectively. According to Burnham, "only four stars in the northern hemisphere have a larger proper motion, and this is common to the principal star and to the binary companion." This proper motion amounts to 4".08 per year. The large common proper motion signifies a physical system. There is little change in the position angle and distance of BC with respect to A. According to Doolittle (*Publications of Flower Observatory*, **2**, 44, 1905), it is probable that the small pair is pursuing a closed orbit about the principal star, but the period must be reckoned in thousands of years. Lewis (*Memoires Royal Astronomical Society*, **56**, 114, 1906) finds a period in the neighborhood of 9000 years. The best orbit for the small pair is that of Doolittle who finds a period of 180 years. The photographs for the present measures were taken in two separate series, one set of plates without rotating sector in order to obtain the brighter star of smaller pair, and the other set with the sector for the principal star. The plates were measured by Mr. Mitchell. The parallaxes obtained were for the star A, $\pi = + 0''.194 \pm 0''.009$, and for B of the binary system BC, the value of π is $+ 0''.214 \pm 0''.008$. Thence the parallax of the triple system is

$$+ 0''.204 \pm 0''.006.$$

For the star A, Boss obtains the proper motion in right ascension of $- 2''.220$ per year. The plates give the proper motion of A equal to $- 2''.224$, which is in good agreement with the value of Boss, but for the star B, the plates give a proper motion which is considerably different, and which amounts to $- 1''.767$ per year. The difference in proper motion is due mainly to orbital motion.

The photographic plates were taken at four different seasons when the position angles and distances of C with respect to B, obtained by using Doolittle's orbit were as follows:

1914.72	18°.8	2".90
15.12	17.4	2.95
15.77	15.3	2.99
16.77	12.0	3.04

In order to obtain the ratios of the mass of B with respect to C it is necessary to know the proper motion of the center of gravity of the system BC. This is unknown, but if we adopt the value of the proper motion of $-2''.20$ in right ascension, obtained by combining Boss's value with that by Lewis, and utilize the measures of plates at the first and fourth seasons, which are separated by only 2.05 years, then the masses of B and C appear about equal. It should be needless to add that little confidence should be placed in this result, both for the reason that the motion of the center of gravity of the system is not known with sufficient accuracy, and also for the reason that the orbital motion in two years for such a slow moving system is very small. This star will be kept on the observing program, and after a lapse of a few years, other plates will be taken in order to obtain the proper and orbital motions with greater accuracy. The only other determination of the mass-ratios of B and C is by Lewis, who finds C of greater mass than B, and the masses of B and C in the ratios of 6 to 6.5. The McCormick value of the parallax gives the mass of the system BC 3.72 times that of the sun; B and C are separated by 22.9 astronomical units, while A is distant from BC by 415 times the distance of earth from sun, or 14 times the distance of Neptune from the sun.

Other values of the parallax of the bright star A have been published:

Parallax.	Authority.	Method.
$+0''.223 \pm 0''.020$	Hall	Equatorial
$.166 \pm .018$	Gill	Heliometer
$.21 \pm .042$	Flint_1	Meridian Circle
$.11 \pm .039$	Flint_2	Meridian Circle
$.060 \pm .127$	Jewdokimov	Meridian Circle
$+0.240$	Adams	Spectrograph

The present measures furnish the first value of the parallax of B to be published.

TABLE 1

PLATES OF o^2 40 ERIDANI, PRINCIPAL STAR A

No.	Date.	Hour Angle.	Observers.	Weight.
1750	1915 Sept. 23	$-0^h.3$	M	1.0
1751	Sept. 23	+0.1	M	1.0
1907	Oct. 29	−0.6	G	0.9
1921	Oct. 30	−0.6	M	1.0
2306	1916 Jan. 13	+0.3	A	0.8
2307	Jan. 13	+0.7	A	0.8
2346	Jan. 23	−0.1	M	0.7
2347	Jan. 23	+0.3	M	0.7
2387	Feb. 9	−0.3	M	0.8
3020	Sept. 17	−0.3	A	1.0
3021	Sept. 17	+0.1	A	1.0
3039	Sept. 19	−0.8	A	1.0
3040	Sept. 19	−0.6	A	1.0
3049	Sept. 20	−1.3	L	0.8
3050	Sept. 20	−0.9	L	0.8

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−43.8	+31.0	+0.309
2	.14	−24.0	−54.1	.438
3	.14	+67.8	+23.1	+0.253
Principal star	0.16	− 6.9	− 8.3	

TABLE 2

REDUCTIONS FOR o^2 40 ERIDANI, PRINCIPAL STAR A

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1750	−0.0668	1.0	+0.891	−151	−0.0017	−0″.03
1751	− .0693	1.0	+ .891	−151	+ .0008	+ .02
1907	− .0838	0.9	+ .475	−115	+ .0009	+ .02
1921	− .0838	1.0	+ .460	−114	+ .0005	+ .01
2306	− .1151	0.8	− .716	− 39	− .0012	− .02
2307	− .1187	0.8	− .716	− 39	+ .0024	+ .04
2346	− .1189	0.7	− .820	− 29	− .0013	− .02
2347	− .1183	0.7	− .820	− 29	− .0019	− .03
2387	− .1274	0.8	− .938	− 12	+ .0011	+ .02
3020	− .1731	1.0	+ .926	+209	− .0005	− .01
3021	− .1719	1.0	+ .926	+209	− .0017	− .03
3039	− .1728	1.0	+ .914	+211	− .0015	− .03
3040	− .1741	1.0	+ .914	+211	− .0002	.00
3049	− .1768	0.8	+ .907	+212	+ .0022	+ .04
3050	−0.1771	0.8	+0.907	+212	+0.0025	+0.04

The normal equations are:

$$13.3c + 5.471\mu + 4.7567\pi = -1.7253 \text{ mm.}$$
$$+ 32.2541\mu + 7.9672\pi = -1.5321 \text{ mm.}$$
$$+ 9.1699\pi = -0.7233 \text{ mm.}$$

from which:

$c = -0.12102$ mm.

$\mu = -0.02928$ mm. $= -0''.6094$, or $-2''.224$ per year.

$\pi = +0.00934$ mm. $= +\mathbf{0''.194 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00104 \text{ mm.} = \pm 0''.022.$$

TABLE 1

PLATES OF o^2 40 ERIDANI, COMPANION, B

No.	Date.	Hour Angle.	Observers.	Weight.
276	1914 Sept. 20	−0ʰ2	M, A	1.0
289	Sept. 21	−0.1	G, Ol	0.8
290	Sept. 21	+0.5	G, Ol	0.7
308	Sept. 23	+0.9	A	1.0
793	1915 Jan. 14	−0.6	Ol	0.6
875	Feb. 10	+0.2	G	1.0
876	Feb. 10	+0.8	G	1.0
934	Feb. 21	+0.8	A	1.0
935	Feb. 22	+0.6	M, G	1.0
936	Feb. 22	+1.1	G	1.0
1661	Sept. 11	−0.9	M	1.0
1662	Sept. 11	−0.3	M	0.4
1833	Oct. 22	−0.5	G	0.7*
1841	Oct. 24	−1.1	G	0.7
1842	Oct. 24	−0.7	G	0.4
1871	Oct. 27	−0.4	A	0.4
3148	1916 Oct. 7	−0.8	M	0.8
3149	Oct. 7	−0.5	M	0.8
3150	Oct. 7	−0.1	M	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−43.8	+31.0	+0.267
2	.14	−24.0	−54.1	.448
3	.14	+67.8	+23.1	+0.285
Companion, B	0.14	− 3.1	− 9.4	

TABLE 2

REDUCTIONS FOR o^2 40 ERIDANI, COMPANION, B

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
276	+0.1006	1.0	+0.911	−155	0.0000	0″.00
289	+ .1004	0.8	+ .904	−154	− .0001	.00
290	+ .0980	0.7	+ .904	−154	+ .0023	+ .04
308	+ .1006	1.0	+ .889	−152	− .0010	− .02
793	+ .0538	0.6	− .730	− 39	− .0026	− .04
875	+ .0390	1.0	− .943	− 12	+ .0024	+ .05
876	+ .0410	1.0	− .943	− 12	+ .0004	+ .01
934	+ .0342	1.0	− .972	− 1	+ .0038	+ .08
935	+ .0408	1.0	− .973	0	− .0030	− .06
936	+ .0396	1.0	− .973	0	− .0018	− .04
1661	− .0015	1.0	+ .962	+201	+ .0027	+ .03
1662	+ .0018	0.4	+ .962	+201	− .0005	− .01
1833	− .0140	0.7	+ .577	+242	− .0002	.00
1841	− .0138	0.7	+ .548	+244	− .0013	− .02
1842	− .0112	0.4	+ .548	+244	− .0039	− .05
1871	− .0161	0.4	+ .504	+247	− .0003	.00
3148	− .1112	0.8	+ .754	+593	+ .0003	.00
3149	− .1116	0.8	+ .754	+593	+ .0007	+ .01
3150	−0.1110	0.8	+0.754	+593	+0.0001	0.00

The normal equations are:

$$14.8c + 15.954\mu + 1.9769\pi = + 0.2796 \text{ mm.}$$
$$+ 110.3633\mu + 11.3318\pi = - 2.2189 \text{ mm.}$$
$$+ 10.8161\pi = - 0.1123 \text{ mm.}$$

from which:

$c = + 0.04777$ mm.

$\mu = - 0.02807$ mm. $= - 0''.5838$, or $- 1''.767$ per year.

$\pi = + 0.01029$ mm. $= + \mathbf{0''.214 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

ξ ERIDANI ($4^h\ 18^m$; $-3°\ 58'$)

According to Holteschek (*Astronomische Nachrichten*, 4738), this star forms one of the Ursa Major group, and on this assumption, it should have a theoretical parallax of + 0″.019. It is A2 type, of magnitude 5.23, and of small proper motion 0″.07. The nineteen plates of the series were measured by Mr. Alden and furnish a parallax + 0″.010 ± 0″.009. The value of the proper motion in right ascension given by Boss is − 0″.050 per year.

TABLE 1

PLATES OF ξ ERIDANI

No.	Date.	Hour Angle.	Observers.	Weight.
202	1914 Sept. 4	−0^h.7	M	0.8
224	Sept. 9	−0.3	M	1.0
236	Sept. 13	−0.1	M, A	1.0
277	Sept. 20	+0.4	M, A	0.9
426	Oct. 27	0.0	Ol	1.0
713	Dec. 26	+0.2	G	0.7*
820	1915 Jan. 21	+0.8	Ol	0.9
862	Feb. 9	+1.0	M	1.0
920	Feb. 20	+0.2	A	1.0
921	Feb. 20	+0.6	A	1.0
947	Feb. 25	+1.1	M	0.8
1650	Sept. 10	−0.2	Ol	0.8
1670	Sept. 12	−0.9	Ol	0.6
1690	Sept. 14	−0.3	A	0.9
1691	Sept. 14	+0.1	A	1.0
2321	1916 Jan. 14	+0.8	Ol	0.9
2378	Feb. 4	+0.2	G	1.0
2396	Feb. 10	−0.6	Ol	0.8
2401	Feb. 14	−0.2	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−32.7	−25.8	+0.2078
2	.16	−29.1	− 6.1	.1971
3	.19	−16.4	+39.7	.1678
4	.13	+18.0	−13.5	.1543
5	.13	+24.9	−35.8	.1559
6	.12	+35.3	+41.5	+0.1171
Parallax star	0.20	− 4.5	− 2.7	

TABLE 2

REDUCTIONS FOR ξ ERIDANI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
202	−0.0084	0.8	+0.990	−240	+0.0041	+0″.07
224	− .0044	1.0	+ .977	−235	.0000	.00
236	− .0061	1.0	+ .962	−231	+ .0016	+ .03
277	− .0036	0.9	+ .924	−224	− .0010	− .02
426	− .0020	1.0	+ .838	−187	− .0030	− .06
713	− .0068	0.7	− .453	−127	+ .0005	+ .01
820	− .0100	0.9	− .788	−101	+ .0033	+ .06
862	− .0039	1.0	− .933	− 82	− .0031	− .06
920	− .0046	1.0	− .970	− 71	− .0025	− .05
921	− .0068	1.0	− .970	− 71	− .0003	− .01
947	− .0086	0.8	− .976	− 66	+ .0014	+ .03
1650	− .0063	0.8	+ .976	+131	− .0021	− .04
1670	− .0113	0.6	+ .967	+133	+ .0029	+ .04
1690	− .0100	0.9	+ .958	+135	+ .0016	+ .03
1691	− .0054	1.0	+ .958	+135	− .0030	− .06
2321	− .0108	0.9	− .708	+257	+ .0002	.00
2378	− .0118	1.0	− .902	+278	+ .0009	+ .02
2396	− .0108	0.8	− .936	+284	+ .0002	.00
2401	−0.0122	0.9	−0.953	+288	−0.0012	−0.02

The normal equations are:

$$17.0c - 0.664\mu - 0.2440\pi = - 0.1258 \text{ mm.}$$
$$+ 61.0428\mu - 10.5622\pi = - 0.0665 \text{ mm.}$$
$$+ 14.2014\pi = + 0.0200 \text{ mm.}$$

from which:

$c = - 0.00743$ mm.
$\mu = - 0.00109$ mm. $= - 0''.0226$, or $- 0''.083$ per year.
$\pi = + 0.00047$ mm. $= + \mathbf{0''.010} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00146 \text{ mm.} = \pm 0''.030.$$

α TAURI ($4^h\ 30^m$; $+16°\ 19'$)

The first magnitude star, Aldebaran, has been many times investigated for parallax with values which are quite discordant. Its magnitude is 1.06, and it is a K5 star, of proper motion $0''.20$ per year. The following values of the parallax have been found:

Parallax.	Authority.	Method.
$+0''.516 \pm 0''.057$	O. Struve	Equatorial
$+ .102 \pm .030$	Hall	Equatorial
$+ .02 \pm .058$	Flint	Meridian Circle
$+ .109 \pm .014$	Elkin	Heliometer
$+ .079 \pm .029$	Donner-Kapteyn	Photography
$- .005 \pm .020$	Küstner-Kapteyn	Photography
$+ .032 \pm .084$	Jewdokimov	Meridian Circle
$+ .047 \pm .010$	Van Biesbroeck	Photography
$+0.051$	Adams	Spectrograph

It was very difficult to obtain a satisfactory series of plates on account of the great brightness of the parallax star. The difficulty was increased from the fact that the only available guiding star was faint, with the consequent trouble that perfect guiding was almost impossible. The plates of the series were measured by Mr. Mitchell who finds a proper motion in right ascension of $+ 0''.072$ per year, while the value due to Boss is $+ 0''.069$.

TABLE 1

PLATES OF α TAURI

No.	Date.	Hour Angle.	Observers.	Weight.
454	1914 Oct. 31	0h0	M	0.6*
556	Nov. 11	−0.2	A	0.6*
892	1915 Feb. 18	+0.5	M	0.7
988	Mar. 3	+0.9	M	0.6*
1772	Oct. 2	−0.1	M	0.8
1773	Oct. 2	+0.2	M	0.5*
1873	Oct. 27	+0.3	A	1.0
2348	1916 Jan. 23	+0.7	M	0.5*
2428	Feb. 29	+1.2	A	0.8
2429	Feb. 29	+1.7	A	0.5*
2438	Mar. 4	+1.1	A	0.5*
3022	Sept. 17	+0.4	A	0.6
3041	Sept. 19	−0.4	A	0.6
3042	Sept. 19	0.0	A	0.5
3151	Oct. 7	+0.1	M	0.5*
3152	Oct. 7	+0.5	M	0.6
3197	Oct. 14	−0.7	M	0.7
3262	Oct. 24	−0.1	M	1.0
3289	Oct. 27	−0.4	M	0.7
3290	Oct. 27	0.0	M	0.8
3333	Nov. 2	−0.8	M	0.8
3687	1917 Feb. 22	+0.1	M	0.8
3688	Feb. 22	+0.4	L	0.6*
3713	Mar. 6	+1.0	M	1.0
3728	Mar. 8	+1.2	L	0.6
4526	Oct. 6	−1.0	M	0.5*
4550	Oct. 9	+0.6	A	0.8
4551	Oct. 9	+0.1	A	0.9

* One exposure.

TABLE 2

REDUCTIONS FOR α TAURI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
454	+0.0278	0.6	+0.512	−604	−0.0012	−0″.02
556	+ .0298	0.6	+ .342	−593	− .0034	− .05
892	+ .0252	0.7	− .962	−494	− .0001	.00
988	+ .0265	0.6	− .979	−481	− .0013	− .02
1772	+ .0254	0.8	+ .877	−268	+ .0050	+ .09
1773	+ .0312	0.5	+ .877	−268	− .0008	− .01
1873	+ .0304	1.0	+ .573	−243	− .0003	− .01
2348	+ .0271	0.5	− .781	−155	+ .0015	+ .02
2428	+ .0275	0.8	− .980	−118	+ .0012	+ .02
2429	+ .0292	0.5	− .980	−118	− .0006	− .01
2438	+ .0315	0.5	− .978	−114	− .0028	− .04
3022	+ .0352	0.6	+ .956	+ 83	− .0014	− .02
3041	+ .0377	0.6	+ .946	+ 85	− .0038	− .06
3042	+ .0340	0.5	+ .946	+ 85	− .0002	.00
3151	+ .0318	0.5	+ .806	+103	+ .0020	+ .03
3152	+ .0303	0.6	+ .806	+103	+ .0035	+ .06
3197	+ .0307	0.7	+ .731	+110	+ .0030	+ .05
3262	+ .0294	1.0	+ .604	+120	+ .0042	+ .09
3289	+ .0350	0.7	+ .563	+123	− .0014	− .02
3290	+ .0343	0.8	+ .563	+123	− .0007	− .01
3333	+ .0361	0.8	+ .475	+129	− .0026	− .05
3687	+ .0281	0.8	− .974	+241	+ .0040	+ .07
3688	+ .0340	0.6	− .974	+241	− .0019	− .03
3713	+ .0323	1.0	− .972	+253	− .0001	.00
3728	+ .0328	0.6	− .971	+255	− .0006	− .01
4526	+ .0396	0.5	+ .819	+467	− .0024	− .04
4550	+ .0387	0.8	+ .788	+470	− .0015	− .03
4551	+0.0388	0.9	+0.788	+470	−0.0016	−0.03

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−56.4	− 0.2	+0.222
2	.13	− 0.6	−16.5	.250
3	.18	+27.7	−31.1	.265
4	.16	+29.3	+47.8	+0.263
Parallax star	0.25	+ 2.4	+ 0.2	

The normal equations are:

$$19.1c + 2.853\mu + 2.4831\pi = + 0.6074 \text{ mm.}$$
$$+ 168.0092\mu + 7.3657\pi = + 0.2610 \text{ mm.}$$
$$+ 12.6821\pi = + 0.1066 \text{ mm.}$$

from which:

$c = + 0.03144$ mm.
$\mu = + 0.00095$ mm. $= + 0''.0197$, or $0''.072$ per year.
$\pi = + 0.00170$ mm. $= + \mathbf{0''.035 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

BOSS 1128 ($4^h\ 42^m$; $+63°\ 20'$)

This star is of 5.81 magnitude, of Mb type, and with a total proper motion $0''.11$ per year. With the exception of two plates measured by Mr. Mitchell, the series of plates were measured by Miss Hawes. A relative parallax $- 0''.003 \pm 0''.011$ resulted, and a proper motion in right ascension $+ 0''.027$ where the corresponding value from Boss is $+ 0''.056$. The spectroscopic parallax of Mt. Wilson is $+ 0''.010$.

TABLE 1

PLATES OF BOSS 1128

No.	Date.	Hour Angle.	Observers.	Weight.
3061	1916 Sept. 23	−1h5	Ol	0.7*
3130	Oct. 1	−0.3	L	1.0
3222	Oct. 20	−0.4	L	0.8
3223	Oct. 20	−0.1	L	0.7*
4668	1917 Nov. 1	−0.3	Ds	1.0
5797	1918 Oct. 12	−0.7	M	0.7
5854	Nov. 2	−0.8	M	1.0
5855	Nov. 2	−0.5	M	1.0
6243	1919 Jan. 13	−1.2	H	1.0
6244	Jan. 13	−0.8	H	1.0
6370	Jan. 28	−0.4	D	1.0
6371	Jan. 28	0.0	D	1.0
6399	Jan. 30	−0.5	H	1.0
6400	Jan. 30	0.0	H	1.0
7670	Sept. 8	−1.0	H	0.8
7671	Sept. 8	−0.7	H	0.8
7693	Sept. 12	−0.3	H	1.0
7723	Sept. 15	−0.9	D	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−39.3	+32.5	+0.136
2	.10	−20.2	−24.4	.172
3	.07	− 9.5	− 6.8	.167
4	.12	− 3.6	−25.9	.179
5	.16	+12.4	−15.5	.179
6	.14	+60.2	+40.0	+0.167
Parallax star	0.13	+ 1.2	− 1.6	

TABLE 2

REDUCTIONS FOR BOSS 1128

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3061	−0.0064	0.7	+0.946	−678	+0.0034	+0″.06
3130	− .0024	1.0	+ .890	−670	− .0006	− .01
3222	− .0049	0.8	+ .698	−651	+ .0020	+ .04
3223	+ .0016	0.7	+ .698	−651	− .0045	− .08
4668	− .0028	1.0	+ .541	−274	+ .0013	+ .03
5797	− .0004	0.7	+ .795	+ 71	+ .0001	.00
5854	+ .0029	1.0	+ .530	+ 92	− .0031	− .06
5855	+ .0015	1.0	+ .530	+ 92	− .0017	− .04
6243	− .0016	1.0	− .630	+164	+ .0018	+ .04
6244	+ .0042	1.0	− .630	+164	− .0040	− .08
6370	+ .0010	1.0	− .805	+179	− .0007	− .01
6371	− .0004	1.0	− .805	+179	+ .0007	+ .01
6399	− .0007	1.0	− .824	+181	+ .0010	+ .02
6400	− .0019	1.0	− .824	+181	+ .0022	+ .05
7670	+ .0001	0.8	+ .997	+402	+ .0007	+ .01
7671	− .0022	0.8	+ .997	+402	+ .0030	+ .06
7693	.0000	1.0	+ .990	+406	+ .0008	+ .02
7723	+0.0025	1.0	+0.982	+409	−0.0016	−0.03

The normal equations are:

$$16.5c + 3.448\mu + 3.8059\pi = -0.0069 \text{ mm.}$$
$$+ 227.5992\mu - 10.8634\pi = +0.0831 \text{ mm.}$$
$$+ 10.4289\pi = -0.0069 \text{ mm.}$$

from which:

$c = -0.00047$ mm.

$\mu = +0.00035$ mm. $= +0''.0074$, or $+0''.027$ per year.

$\pi = -0.00013$ mm. $= -\mathbf{0''.003 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00153 \text{ mm.} = \pm 0''.032.$$

π^3 ORIONIS ($4^h\ 44^m$; $+6°\ 47'$)

Adams finds the spectroscopic parallax of this star to be $+ 0''.151$. It has a total proper motion of $0''.47$ per year, it is of magnitude 3.31, and of type F8. The fifteen plates of the series were measured by Mr. Mitchell, who found a proper motion in right ascension of $+ 0''.497$ per year, while the value of Boss is $+ 0''.471$.

TABLE 1

PLATES OF π^3 ORIONIS

No.	Date.	Hour Angle.	Observers.	Weight.
394	1914 Oct. 11	$+0^h.1$	A	1.0
440	Oct. 30	−0.2	A	0.7
516	Nov. 5	−0.2	A	1.0
524	Nov. 6	+0.6	G	0.9
750	1915 Jan. 7	+1.0	Ol	0.8
1013	Mar. 9	+1.5	A	0.7
1026	Mar. 10	+1.7	M	0.7
1710	Sept. 16	−0.8	Ol	0.7
1788	Oct. 8	−0.5	G	0.7
1795	Oct. 9	−0.5	M	0.7
1968	Nov. 5	−0.2	Ol	0.7
2388	1916 Feb. 9	−0.3	G	1.0
2389	Feb. 9	+0.1	G	0.9
2455	Mar. 11	+1.3	M	0.7
2471	Mar. 12	+1.4	M	0.7

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−48.4	+ 9.5	+0.255
2	.15	−15.6	+11.7	.278
3	.15	+18.7	+ 4.8	.274
4	.15	+45.3	−26.0	+0.192
Parallax star	0.20	− 2.8	+ 2.0	

TABLE 2

REDUCTIONS FOR π^3 ORIONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
394	−0.0208	1.0	+0.811	−253	+0.0014	+0″.03
440	− .0194	0.7	+ .581	−234	− .0004	− .01
516	− .0202	1.0	+ .494	−228	+ .0001	.00
524	− .0174	0.9	+ .478	−227	− .0027	− .05
750	− .0256	0.8	− .540	−165	+ .0022	+ .04
1013	− .0233	0.7	− .981	−104	+ .0007	+ .01
1026	− .0209	0.7	− .980	−103	− .0017	− .03
1710	+ .0005	0.7	+ .984	+ 87	+ .0036	+ .06
1788	+ .0047	0.7	+ .842	+109	− .0002	.00
1795	+ .0058	0.7	+ .833	+110	− .0013	− .02
1968	+ .0064	0.7	+ .497	+137	− .0025	− .04
2388	+ .0014	1.0	− .900	+233	− .0014	− .03
2389	− .0006	0.9	− .900	+233	+ .0006	+ .01
2455	+ .0004	0.7	− .978	+264	+ .0011	+ .02
2471	+0.0010	0.7	−0.974	+265	+0.0006	+0.01

The normal equations are:

$$11.9c - 0.029\mu - 0.5300\pi = - 0.1076 \text{ mm.}$$
$$+ 47.3793\mu - 8.2115\pi = + 0.2509 \text{ mm.}$$
$$+ 7.6282\pi = + 0.0062 \text{ mm.}$$

from which:

$c = - 0.00871$ mm.

$\mu = + 0.00655$ mm. $= + 0''.1362$, or $+ 0''.497$ per year.

$\pi = + 0.00725$ mm. $= + \mathbf{0''.151 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00111 \text{ mm.} = \pm 0''.023.$$

A. G. LEIPZIG 1819 ($4^h\ 44^m$; $+6°\ 46'$)

This star was on the series of plates that were taken for π^3 Orionis, and its parallax, therefore, was determined with little extra labor. Its magnitude is 7.02 and spectral type A2.

The proper motion is small, and a small parallax would be pected. The series of plates were measured by Mr. Mitchell

TABLE 1

PLATES OF A. G. LEIPZIG 1819

No.	Date.	Hour Angle.	Observers.	Weight.
394	1914 Oct. 11	+0h1	A	1.0
440	Oct. 30	−0.2	A	0.7
516	Nov. 5	−0.2	A	1.0
524	Nov. 6	+0.6	G	0.9
750	1915 Jan. 7	+1.0	Ol	0.7
1013	Mar. 9	+1.5	A	0.7
1026	Mar. 10	+1.7	M	0.7
1710	Sept. 16	−0.8	Ol	0.7
1788	Oct. 8	−0.5	G	0.5
1795	Oct. 9	−0.5	M	0.7
1968	Nov. 5	−0.2	Ol	0.5
2388	1916 Feb. 9	−0.3	G	0.7
2389	Feb. 9	+0.1	G	0.9
2455	Mar. 11	+1.3	M	0.7
2471	Mar. 12	+1.4	M	0.5

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence
	mm.	mm.	mm.	
2	0.15	−31.7	+14.9	+0.151
3	.15	+ 2.6	+ 8.0	.666
4	.15	+29.1	−22.9	+0.183
Parallax star	0.28	+ 2.3	+ 3.4	

The normal equations are:

$$10.9c - 1.585\mu - 0.2790\pi = +0.0069 \text{ mm.}$$
$$+43.4609\mu - 7.4750\pi = -0.0152 \text{ mm.}$$
$$+6.9751\pi = +0.0018 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR A. G. LEIPZIG 1819

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
394	+0.0045	1.0	+0.811	−253	−0.0031	−0″.06
440	+ .0031	0.7	+ .581	−234	− .0018	− .03
516	+ .0028	1.0	+ .494	−228	− .0015	− .03
524	+ .0005	0.9	+ .478	−227	+ .0008	+ .02
750	− .0025	0.7	− .540	−165	+ .0037	+ .06
1013	+ .0006	0.7	− .981	−104	+ .0004	+ .01
1026	− .0022	0.7	− .980	−103	+ .0032	+ .06
1710	+ .0017	0.7	+ .984	+ 87	− .0015	− .03
1788	− .0046	0.5	+ .842	+109	+ .0047	+ .07
1795	− .0015	0.7	+ .833	+110	+ .0016	+ .03
1968	− .0047	0.5	+ .497	+137	+ .0047	+ .07
2388	+ .0026	0.7	− .900	+233	− .0027	− .05
2389	+ .0022	0.9	− .900	+233	− .0023	− .04
2455	− .0023	0.7	− .978	+264	+ .0021	+ .03
2471	+0.0044	0.5	−0.974	+265	−0.0046	−0.07

from which:

$c = + 0.00058$ mm.

$\mu = - 0.00035$ mm. $= - 0''.0072$, or $- 0''.026$ per year.

$\pi = - 0.00010$ mm. $= \mathbf{- 0''.002 \pm 0''.015}$.

Probable error of plate of unit weight

$$\pm 0.00176 \text{ mm.} = \pm 0''.037.$$

W. B. 4^h 1189 (4^h 56^m; $-5°$ 52′)

This star of 6.5 magnitude, and K9 type has a considerable proper motion of 1″.25. Two values of the parallax have been found visually: Flint with the meridian circle obtaining the result $+ 0''.29 \pm 0''.042$, and Smith with the Yale heliometer deriving the value $+ 0''.104 \pm 0''.015$. There are two photographic values: $+ 0''.111 \pm 0''.019$ from Swarthmore, and $+ 0''.107 \pm 0''.006$ from Allegheny. Mt. Wilson obtains the spectroscopic

parallax + 0″.115. Mr. Olivier measured the McCormick series of plates, and obtained the parallax of + 0″.124 ± 0″.007, with a proper motion in right ascension of + 0″.562 per year, while the value given by Porter is + 0″.550.

TABLE 1

PLATES OF W. B. 4^h 1189

No.	Date.	Hour Angle.	Observers.	Weight.
3029	1916 Sept. 18	$-0^h.7$	L	0.9
3030	Sept. 18	−0.4	L	0.9
3086	Sept. 24	−0.6	L	0.8
3087	Sept. 24	−0.2	L	0.8
3620	1917 Jan. 26	−0.6	Ol	0.9
3621	Jan. 26	−0.3	Ol	0.9
3645	Feb. 6	0.0	M	1.0
3655	Feb. 12	+0.5	A	0.9
3656	Feb. 12	+0.8	A	1.0
4570	Oct. 13	−0.2	B	0.8
4571	Oct. 13	+0.2	B	0.8
4615	Oct. 21	−0.2	B	0.9
4616	Oct. 21	+0.2	B	0.9
5080	1918 Feb. 13	+0.7	M	0.7
5115	Feb. 22	+0.7	Ol	0.7
5170	Mar. 5	+0.8	Ol	0.9
5171	Mar. 5	+1.2	Ol	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−52.7	−19.9	+0.1756
2	.14	−10.7	+42.4	.1754
3	.19	− 6.1	−45.7	.2155
4	.27	+33.2	+32.9	.2068
5	.19	+36.3	− 9.7	+0.2267
Parallax star	0.21	+ 2.7	− 1.3	

TABLE 2

REDUCTIONS FOR W. B. 4^h 1189

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3029	+0.0053	0.9	+0.981	−258	−0.0009	−0″.02
3030	+ .0035	0.9	+ .981	−258	+ .0009	+ .02
3086	+ .0051	0.8	+ .955	−252	− .0004	− .01
3087	+ .0040	0.8	+ .955	−252	+ .0007	+ .01
3620	+ .0038	0.9	− .762	−128	− .0002	.00
3621	+ .0026	0.9	− .762	−128	+ .0010	+ .02
3645	+ .0034	1.0	− .868	−117	+ .0004	+ .01
3655	+ .0054	0.9	− .912	−111	− .0014	− .03
3656	+ .0038	1.0	− .912	−111	+ .0002	.00
4570	+ .0332	0.8	+ .812	+132	− .0010	− .02
4571	+ .0336	0.8	+ .812	+132	− .0014	− .02
4615	+ .0317	0.9	+ .724	+140	+ .0006	+ .01
4616	+ .0310	0.9	+ .724	+140	+ .0013	+ .02
5080	+ .0342	0.7	− .917	+255	− .0032	− .06
5115	+ .0338	0.7	− .963	+264	− .0024	− .04
5170	+ .0287	0.9	− .986	+275	+ .0034	+ .07
5171	+0.0312	1.0	−0.986	+275	+0.0009	+0.02

The normal equations are:

$$14.8c - 0.769\mu - 1.2656\pi = + 0.2475 \text{ mm.}$$
$$+ 58.9162\mu - 8.7406\pi = + 0.3701 \text{ mm.}$$
$$+ 11.6538\pi = - 0.0172 \text{ mm.}$$

from which:

$c = + 0.01762$ mm.

$\mu = + 0.00740$ mm. $= + 0''.1539$, or $+ 0''.562$ per year.

$\pi = + 0.00598$ mm. $= + \mathbf{0''.124 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00101 \text{ mm.} = \pm 0''.021.$$

ϵ LEPORIS (5^h 1^m; $-22°$ 30′)

The only value of the parallax is the spectroscopic result of Adams who finds the parallax $+ 0''.018$. The star is of K5 type,

of magnitude 3.95, and of 0″.07 total annual proper motion. Mr. Briggs measured the seventeen plates of the series, and found the proper motion in right ascension to be + 0″.026 per year, while the value due to Boss is + 0″.026.

TABLE 1

PLATES OF ϵ LEPORIS

No.	Date.	Hour Angle.	Observers.	Weight.
368	1914 Oct. 1	−0ʰ.7	M	0.9
1808	1915 Oct. 10	−0.4	A	0.9
1809	Oct. 10	0.0	A	1.0
1908	Oct. 29	−0.9	G	0.8
1909	Oct. 29	−0.4	G	0.8
2271	1916 Jan. 3	−0.2	G	0.9
2272	Jan. 3	+0.2	G	0.8
2327	Jan. 17	+0.2	G	0.7
3100	Sept. 26	−0.8	L	0.5*
3131	Oct. 1	−0.3	L	0.9
3610	1917 Jan. 25	−0.1	L	1.0
3735	Mar. 9	+0.9	Ol, L	0.9
4440	Sept. 18	−0.1	B	0.8
4454	Sept. 19	−0.2	A	0.9
4479	Sept. 26	+0.4	B	0.9
4494	Oct. 1	−0.4	B	1.0
4495	Oct. 1	0.0	B	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−48.5	−24.5	+0.1575
2	.14	+ 4.0	+29.3	.2622
3	.23	+12.3	+26.5	.2769
4	.18	+32.2	−31.3	+0.3034
Parallax star	0.23	+ 6.59	+ 1.67	

TABLE 2

REDUCTIONS FOR ϵ LEPORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
368	+0.0049	0.9	+0.925	−681	+0.0001	+0″.00
1808	+ .0070	0.9	+ .858	−307	− .0007	− .01
1809	+ .0076	1.0	+ .858	−307	− .0013	− .03
1908	+ .0035	0.8	+ .647	−288	+ .0027	+ .05
1909	+ .0061	0.8	+ .647	−288	+ .0001	.00
2271	+ .0068	0.9	− .426	−222	− .0013	− .02
2272	+ .0033	0.8	− .426	−222	+ .0022	+ .04
2327	+ .0050	0.7	− .630	−208	+ .0004	+ .01
3100	+ .0122	0.5	+ .952	+ 45	− .0046	− .07
3131	+ .0064	0.9	+ .922	+ 50	+ .0012	+ .02
3610	+ .0086	1.0	− .738	+166	− .0020	− .04
3735	+ .0055	0.9	− .988	+209	+ .0011	+ .02
4440	+ .0088	0.8	+ .986	+402	.0000	.00
4454	+ .0039	0.9	+ .983	+403	+ .0049	+ .10
4479	+ .0090	0.9	+ .953	+410	− .0002	.00
4494	+ .0124	1.0	+ .923	+415	− .0036	− .07
4495	+0.0083	1.0	+0.923	+415	+0.0005	+0.01

The normal equations are:

$$14.7c + 1.249\mu + 6.3885\pi = + 0.1030 \text{ mm.}$$
$$168.4559\mu + 4.3290\pi = + 0.0703 \text{ mm.}$$
$$10.2350\pi = + 0.0521 \text{ mm.}$$

from which:

$c = + 0.00663$ mm.

$\mu = + 0.00035$ mm. $= + 0''.0072$, or $+ 0''.026$ per year.

$\pi = + 0.00081$ mm. $= + \mathbf{0''.017 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00146 \text{ mm.} = \pm 0''.030.$$

λ AURIGÆ ($5^h\ 12^m$; $+40°\ 0'$)

This star of magnitude 4.85 and of Go type has a considerable total proper motion 0″.846. Its parallax has been several times

determined as follows: Chase with the heliometer derived the value $+0''.112 \pm 0''.041$, Kostinsky by photography $+0''.10 \pm 0''.02$, Flint by meridian circle $+0''.077 \pm 0''.028$, and Abetti by meridian circle $+0''.111 \pm 0''.030$, Swarthmore Observatory by photography $+0''.069 \pm 0''.008$, and Mt. Wilson by the

TABLE 1

PLATES OF λ AURIGÆ

No.	Date.	Hour Angle.	Observers.	Weight.
4528	1917 Oct. 6	$-0^h.7$	M	1.0
4585	Oct. 15	−1.1	B	0.9
4586	Oct. 15	−0.8	B	0.9
4719	Nov. 16	−0.9	Ds	0.9
4720	Nov. 16	−0.5	Ds	0.9
5126	1918 Feb. 23	−0.2	M	0.9
5856	Nov. 2	−0.6	M	0.9
5857	Nov. 2	−0.3	M	1.0
6199	1919 Jan. 8	−0.3	F	1.0
6284	Jan. 20	−1.2	F	0.9
6285	Jan. 20	−0.9	F	0.7
6306	Jan. 21	−0.3	D	1.0
7785	Sept. 24	−0.8	D	1.0
7786	Sept. 24	−0.3	D	1.0
7953	Oct. 19	−0.5	A	1.0
7954	Oct. 19	−0.1	A	1.0
8548	1920 Feb. 8	−0.5	M	0.6
8549	Feb. 8	−0.1	M	0.9

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.07	−37.2	− 5.0	+0.236
2	.09	−16.6	+ 2.0	.195
3	.12	− 0.7	+11.8	.142
4	.08	+21.9	+ 4.6	.171
5	.10	+32.6	−13.4	+0.256
Parallax star	0.13	− 0.1	− 1.7	

spectrograph + 0″.066. Miss France measured the McCormick plates and found the parallax + 0″.064 ± 0″.009 with a proper motion in right ascension + 0″.534 where the corresponding value from Boss is + 0″.529.

TABLE 2

REDUCTIONS FOR λ AURIGÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4528	−0.0326	1.0	+0.908	−418	+0.0036	+0″.07
4585	− .0296	0.9	+ .832	−409	+ .0010	+ .02
4586	− .0278	0.9	+ .832	−409	− .0008	− .01
4719	− .0251	0.9	+ .416	−377	− .0025	− .05
4720	− .0282	0.9	+ .416	−377	+ .0006	+ .01
5126	− .0229	0.9	− .954	−278	− .0020	− .04
5856	− .0010	0.9	+ .626	− 26	− .0013	− .02
5857	− .0008	1.0	+ .626	− 26	− .0015	− .03
6199	+ .0014	1.0	− .468	+ 41	− .0024	− .05
6284	− .0013	0.9	− .639	+ 53	+ .0007	+ .01
6285	− .0014	0.7	− .639	+ 53	+ .0008	+ .01
6306	− .0035	1.0	− .652	+ 54	+ .0029	+ .06
7785	+ .0219	1.0	+ .978	+300	− .0002	.00
7786	+ .0194	1.0	+ .978	+300	+ .0023	+ .05
7953	+ .0244	1.0	+ .797	+325	− .0015	− .03
7954	+ .0243	1.0	+ .797	+325	− .0014	− .03
8548	+ .0229	0.6	− .849	+437	+ .0028	+ .05
8549	+0.0261	0.9	−0.849	+437	−0.0004	−0.01

The normal equations are:

$$16.5c - 0.471\mu + 3.6193\pi = -0.0316 \text{ mm.}$$
$$+ 148.9297\mu - 6.2685\pi = +1.0286 \text{ mm.}$$
$$+ 9.5077\pi = -0.0233 \text{ mm.}$$

from which:

$c = -0.00239$ mm.

$\mu = +0.00703$ mm. $= +0''.1462$, or $+0''.534$ per year.

$\pi = +0.00309$ mm. $= +$ **0″.064 ± 0″.009**.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

β LEPORIS ($5^h\ 24^m$; $-20°\ 50'$)

Like the star α Leporis, the only parallax published is that by Adams, who gives the result $+\ 0''.038$. The star is of G type, of magnitude 2.96, and of small proper motion, $0''.09$ per year. The plates were measured by Mr. Olivier, who found the proper motion in right ascension to be $+\ 0''.007$ while the value from Boss is $+\ 0''.006$.

TABLE 1

PLATES OF β LEPORIS

No.	Date.	Hour Angle.	Observers.	Weight.
570	1914 Nov. 12	$+0^h.1$	M	0.9
805	1915 Jan. 15	−0.1	G	0.4*
1892	Oct. 28	−0.6	Ol	0.8
1969	Nov. 5	+0.1	Ol	0.8
2022	Nov. 16	+0.3	G	0.9
2055	Nov. 24	+0.1	G	0.5
2379	1916 Feb. 4	0.0	G	0.5*
2403	Feb. 14	0.0	G	0.8
2404	Feb. 14	+0.5	G	0.9
2426	Feb. 27	+0.2	M	1.0
2427	Feb. 27	+0.6	M	0.8
3088	Sept. 24	0.0	L	0.9
3102	Sept. 26	−0.3	L	0.9
3103	Sept. 26	+0.1	L	0.7*
3245	Oct. 22	−0.1	L	0.9
3246	Oct. 22	+0.4	L	1.0
3593	1917 Jan. 17	+0.5	Ol	0.6*
3641	Jan. 30	−0.3	M	1.0
3642	Jan. 30	0.0	M	0.9
3671	Feb. 16	−0.4	Ol	0.9
3672	Feb. 16	+0.1	Ol	0.9

* One exposure.

TABLE 2

REDUCTIONS FOR β LEPORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
570	+0.0007	0.9	+0.521	−541	+0.0011	+0″.02
805	+ .0020	0.4	− .535	−477	− .0001	.00
1892	+ .0039	0.8	+ .721	−191	− .0018	− .03
1969	+ .0035	0.8	+ .624	−183	− .0014	− .02
2022	+ .0014	0.9	+ .465	−172	+ .0007	+ .01
2055	+ .0006	0.5	+ .337	−164	+ .0016	+ .02
2379	+ .0046	0.5	− .786	− 92	− .0023	− .03
2403	+ .0038	0.8	− .879	− 82	− .0015	− .03
2404	+ .0007	0.9	− .879	− 82	+ .0016	+ .03
2426	+ .0020	1.0	− .960	− 69	+ .0003	+ .01
2427	+ .0027	0.8	− .960	− 69	− .0004	− .01
3088	+ .0017	0.9	+ .985	+141	+ .0007	+ .01
3102	+ .0024	0.9	+ .978	+143	.0000	.00
3103	+ .0013	0.7	+ .978	+143	+ .0011	+ .02
3245	+ .0025	0.9	+ .785	+169	− .0001	.00
3246	+ .0036	1.0	+ .785	+169	− .0012	− .02
3593	+ .0005	0.6	− .571	+256	+ .0021	+ .03
3641	+ .0036	1.0	− .739	+269	− .0010	− .02
3642	+ .0016	0.9	− .739	+269	+ .0010	+ .02
3671	+ .0032	0.9	− .901	+286	− .0006	− .01
3672	+0.0023	0.9	−0.901	+286	+0.0003	+0.01

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.24	−23.5	−36.5	+0.2239
2	.25	−13.7	−17.5	.2034
3	.18	− 5.5	−27.9	.2598
4	.20	− 1.1	+53.5	.0465
5	.14	+43.8	+28.4	+0.2664
Parallax star	0.21	+ 2.1	− 8.9	

The normal equations are:

$$17.0c + 3.330\mu - 1.1231\pi = + 0.0398 \text{ mm.}$$
$$+ 90.3624\mu - 5.0323\pi = + 0.0160 \text{ mm.}$$
$$+ 10.8877\pi = - 0.0037 \text{ mm.}$$

from which:

$c = + 0.00232$ mm.

$\mu = + 0.00009$ mm. $= + 0''.0018$, or $+ 0''.007$ per year.

$\pi = - 0.00006$ mm. $= - \mathbf{0''.001 \pm 0''.005}$.

Probable error of plate of unit weight

$$\pm 0.00074 \text{ mm.} = \pm 0''.015.$$

W. B. 5^h592 (5^h 26^m; $-3°$ 42′)

This star of 8.9 magnitude, of type Ma has a considerable proper motion 2″.22 per year. Miss Darkow measured the McCormick plates and derived a relative parallax + 0″.163 ± 0″.009, with a proper motion in right ascension + 0″.811 where the corresponding value from Porter is + 0″.744.

The parallax has been several times determined as follows:

Parallax.	Authority.	Method.
+0″.06 ±0″.036	Flint	Meridian circle
+ .189± .010	Schlesinger	Photography
+ .136± .065	Kimberg	Photography
+ .203± .118	Jewdokimov	Meridian circle
+0.166	Mt. Wilson	Spectrograph

TABLE 1

PLATES OF W. B. 5^h592

No.	Date.	Hour Angle.	Observers.	Weight.
4683	1917 Nov. 2	-0^h7	M	0.5
4691	Nov. 3	−0.1	Ds	0.5
4692	Nov. 3	+0.3	Ds	0.9
4729	Nov. 7	−1.2	B	0.9
4730	Nov. 7	−0.8	B	0.9
4802	Nov. 22	+0.2	B	0.9
5094	1918 Feb. 17	−0.6	M	0.6*
5095	Feb. 17	−0.2	M	0.6*
5715	Sept. 22	−0.8	M	0.8
5716	Sept. 22	−0.4	M	1.0
5883	Nov. 5	−0.6	M	1.0
5884	Nov. 5	−0.2	M	1.0
6256	1919 Jan. 15	+0.3	D	0.8
6257	Jan. 15	+0.8	D	0.9
6362	Jan. 27	−0.5	D	1.0
6363	Jan. 27	−0.1	D	0.9
6600	Mar. 3	+0.1	D	1.0
6601	Mar. 3	+0.4	D	1.0
7724	Sept. 15	−1.0	D	1.0
7725	Sept. 15	−0.7	D	0.8
7744	Sept. 16	−1.1	D	1.0
7745	Sept. 16	−0.7	D	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−37.5	− 5.4	+0.164
2	.11	−13.9	− 9.7	.192
3	.13	+ 4.0	+48.8	.169
4	.11	+ 5.3	−19.5	.220
5	.15	+42.1	−14.2	+0.255
Parallax star	0.15	+ 3.7	− 2.4	

TABLE 2

REDUCTIONS FOR W. B. 5^h592

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4683	−0.0506	0.5	+0.665	−323	−0.0024	−0″.04
4691	− .0586	0.5	+ .652	−322	+ .0056	+ .08
4692	− .0542	0.9	+ .652	−322	+ .0012	+ .02
4729	− .0534	0.9	+ .598	−318	+ .0004	+ .01
4730	− .0516	0.9	+ .598	−318	− .0014	− .03
4802	− .0534	0.9	+ .371	−303	+ .0002	.00
5094	− .0498	0.6	− .902	−216	− .0041	− .07
5095	− .0483	0.6	− .902	−216	− .0056	− .09
5715	− .0148	0.8	+ .994	+ 1	− .0010	− .02
5716	− .0166	1.0	+ .994	+ 1	+ .0008	+ .02
5883	− .0134	1.0	+ .629	+ 45	− .0006	− .01
5884	− .0165	1.0	+ .629	+ 45	+ .0025	+ .05
6256	− .0165	0.8	− .527	+116	+ .0010	+ .02
6257	− .0179	0.9	− .527	+116	+ .0024	+ .05
6362	− .0180	1.0	− .690	+128	+ .0025	+ .05
6363	− .0154	0.9	− .690	+128	− .0001	.00
6600	− .0134	1.0	− .975	+163	− .0006	− .01
6601	− .0150	1.0	− .975	+163	+ .0010	+ .02
7724	+ .0228	1.0	+1.004	+359	− .0003	− .01
7725	+ .0262	0.8	+1.004	+359	− .0037	− .07
7744	+ .0228	1.0	+1.003	+360	− .0002	.00
7745	+0.0232	1.0	+1.003	+360	−0.0006	−0.01

The normal equations are:

$$19.0c + 5.078\mu + 4.2767\pi = -0.3630 \text{ mm.}$$
$$+ 112.0341\mu + 2.2877\pi = +1.0943 \text{ mm.}$$
$$+ 12.2343\pi = +0.0191 \text{ mm.}$$

from which:

$c = -0.02373$ mm.

$\mu = +0.01068$ mm. $= +0''.2222$, or $+0''.811$ per year.

$\pi = +0.00786$ mm. $= +$ **0″.164** $\pm$ **0″.009**.

Probable error of plate of unit weight is

$$\pm 0.00142 \text{ mm.} = \pm 0''.030.$$

α LEPORIS ($5^h\ 28^m$; $-17°\ 53'$)

The only parallax so far published of this star is the spectroscopic value of Adams, + 0".019. The star is of F type, and of magnitude 2.69, and with a total proper motion less than 0".01 per year. The twenty-three plates of the series were measured by Mr. Mitchell, who found the proper motion in right ascension to be + 0".023 per year while the value due to Boss is + 0".001.

TABLE 1

PLATES OF α LEPORIS

No.	Date.	Hour Angle.	Observers.	Weight.
455	1914 Oct. 31	−0h3	M	0.7
483	Nov. 3	−0.8	G	0.7
532	Nov. 9	−0.2	G	0.6
616	Nov. 22	0.0	A	0.7
821	1915 Jan. 21	+0.7	Ol	0.7
836	Jan. 29	−0.4	G	0.7
853	Feb. 8	+1.2	Ol	0.6
989	Mar. 3	+0.6	G	0.7
1729	Sept. 21	−1.2	G	0.7
1730	Sept. 21	−0.6	G	0.7
1759	Sept. 24	−0.2	G	0.7
1789	Oct. 8	−0.6	G	0.8
3153	1916 Oct. 7	+0.1	M	0.9
3154	Oct. 7	+0.4	M	0.8
3155	Oct. 7	+0.8	M	0.8
3264	Oct. 24	0.0	M	0.8
3265	Oct. 24	+0.4	M	0.8
3630	1917 Jan. 28	−0.3	M	1.0
3631	Jan. 28	+0.2	M	0.8
3666	Feb. 14	−0.5	A	1.0
3667	Feb. 14	−0.2	A	1.0
3689	Feb. 22	+0.3	L	1.0
3690	Feb. 22	+0.7	L	1.0

TABLE 2

REDUCTIONS FOR α LEPORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
455	+0.0034	0.7	+0.699	−453	−0.0040	−0″.07
483	− .0032	0.7	+ .662	−450	+ .0026	+ .04
532	− .0016	0.6	+ .580	−444	+ .0009	+ .01
616	− .0028	0.7	+ .382	−431	+ .0021	+ .04
821	− .0011	0.7	− .607	−371	+ .0001	.00
836	− .0001	0.7	− .710	−363	− .0009	− .01
853	− .0012	0.6	− .820	−353	+ .0002	.00
989	− .0018	0.7	− .973	−330	+ .0008	+ .01
1729	+ .0012	0.7	+ .998	−128	− .0007	− .01
1730	.0000	0.7	+ .998	−128	+ .0005	+ .01
1759	+ .0012	0.7	+ .991	−125	− .0007	− .01
1789	+ .0022	0.8	+ .924	−111	− .0017	− .03
3153	− .0021	0.9	+ .926	+253	+ .0037	+ .07
3154	+ .0022	0.8	+ .926	+253	− .0006	+ .01
3155	+ .0018	0.8	+ .926	+253	− .0002	.00
3264	+ .0003	0.8	+ .775	+270	+ .0013	+ .02
3265	+ .0038	0.8	+ .775	+270	− .0022	− .04
3630	+ .0030	1.0	− .704	+367	− .0018	− .04
3631	+ .0019	0.8	− .704	+367	− .0007	− .01
3666	− .0028	1.0	− .878	+384	+ .0040	+ .08
3667	+ .0034	1.0	− .878	+384	− .0022	− .05
3689	+ .0028	1.0	− .934	+392	− .0016	− .03
3690	−0.0002	1.0	−0.934	+392	+0.0014	−0.03

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−40.8	−44.3	+0.0951
2	.18	−25.6	+14.5	.1545
3	.10	−22.4	+49.3	.1844
4	.10	− 0.7	+27.9	.1877
5	.20	+43.0	+11.9	.2151
6	.14	+46.5	−59.3	+0.1632
Parallax star	0.15	+ 4.8	+ 5.2	

The normal equations are:

$$18.2c + 7.648\mu + 0.9670\pi = + 0.0102 \text{ mm.}$$
$$+ 203.8368\mu - 12.6219\pi = + 0.0590 \text{ mm.}$$
$$+ 12.6779\pi = + 0.0021 \text{ mm.}$$

from which:

$c = + 0.00041$ mm.

$\mu = + 0.00030$ mm. $= + 0''.0063$, or $+ 0''.023$ per year.

$\pi = + 0.00044$ mm. $= + \mathbf{0''.009 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

GROOMBRIDGE 990 ($5^h\ 30^m$; $+51°\ 23'$)

Three parallax values have been published for this star, the heliometer result of Chase with the value $+ 0''.015 \pm 0''.037$, the Allegheny photographic result $+ 0''.035 \pm 0''.006$, and the spectroscopic value of Mt. Wilson, $+ 0''.048$. The star is of magnitude 8.1, of spectral type K, and of total proper motion, $0''.56$. Miss France measured the plates, and derived the relative parallax of $+ 0''.024 \pm 0''.007$, while the proper motion in right ascension amounted to $- 0''.567$ while the corresponding result of Porter is $- 0''.552$.

TABLE 1

PLATES OF GROOMBRIDGE 990

No.	Date.	Hour Angle.	Observers.	Weight.
3224	1916 Oct. 20	−0h3	L	0.7
3225	Oct. 20	0.0	L	0.7
3335	Nov. 2	−0.2	M	0.7
3358	Nov. 7	−0.5	L	1.0
3359	Nov. 7	−0.1	L	1.0
3669	1917 Feb. 16	−0.4	L	1.0
3670	Feb. 16	−0.1	L, Ol	0.9
4546	Oct. 7	−0.2	Ol	1.0
4547	Oct. 7	+0.1	Ol	0.7
4706	Nov. 5	−0.6	B	1.0
4707	Nov. 5	−0.2	B	1.0
5064	1918 Feb. 12	−0.8	Ol	1.0
5065	Feb. 12	−0.3	Ds	1.0
5691	Sept. 14	−1.3	M	1.0
5703	Sept. 21	−1.1	M	1.0
5704	Sept. 21	−0.7	M	1.0
5828	Oct. 21	−0.6	M	1.0
6269	1919 Jan. 19	−0.6	M	1.0
6270	Jan. 19	−0.2	M	1.0
6334	Jan. 24	−0.5	D	1.0
6335	Jan. 24	−0.1	D	1.0
6581	Feb. 27	−0.5	M	1.0
6582	Feb. 27	−0.1	M	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−21.7	−15.4	+0.129
2	.16	−18.8	− 1.0	.232
3	.10	+ 5.0	+27.0	.443
4	.11	+35.5	−10.6	+0.196
Parallax star	0.14	+ 2.0	+ 7.7	

TABLE 2

REDUCTIONS FOR GROOMBRIDGE 990

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3224	+0.0184	0.7	+0.823	−459	−0.0010	−0″.02
3225	+ .0141	0.7	+ .823	−459	+ .0033	+ .06
3335	+ .0138	0.7	+ .675	−446	+ .0024	+ .04
3358	+ .0170	1.0	+ .609	−441	− .0012	− .02
3359	+ .0199	1.0	+ .609	−441	− .0041	− .08
3669	+ .0057	1.0	− .889	−340	+ .0008	+ .02
3670	+ .0070	0.9	− .889	−340	− .0005	− .01
4546	− .0114	1.0	+ .931	−107	+ .0026	+ .05
4547	− .0097	0.7	+ .931	−107	+ .0009	+ .02
4706	− .0124	1.0	+ .639	− 78	+ .0011	+ .02
4707	− .0122	1.0	+ .639	− 78	+ .0009	+ .02
5064	− .0188	1.0	− .853	+ 21	− .0016	− .03
5065	− .0204	1.0	− .853	+ 21	.0000	.00
5691	− .0326	1.0	+1.003	+235	− .0017	− .04
5703	− .0354	1.0	+ .998	+242	+ .0006	+ .01
5704	− .0319	1.0	+ .998	+242	− .0029	− .06
5828	− .0376	1.0	+ .818	+272	+ .0003	+ .01
6269	− .0451	1.0	− .569	+362	− .0005	− .01
6270	− .0461	1.0	− .569	+362	+ .0005	+ .01
6334	− .0472	1.0	− .638	+367	+ .0012	+ .02
6335	− .0476	1.0	− .638	+367	+ .0016	+ .03
6581	− .0502	1.0	− .954	+401	+ .0012	+ .02
6582	−0.0468	1.0	−0.954	+401	−0.0022	−0.04

The normal equations are:

$$21.7c + 4.723\mu + 1.8033\pi = -0.4212 \text{ mm.}$$
$$+ 217.4715\mu - 17.1142\pi = -1.7294 \text{ mm.}$$
$$+ 14.2049\pi = +0.1121 \text{ mm.}$$

from which:

$c = -0.01788$ mm.

$\mu = -0.00747$ mm. $= -0''.1554$, or $-0''.567$ per year.

$\pi = +0.00116$ mm. $= +$ **0″.024 ± 0″.007.**

Probable error of plate of unit weight

$$\pm 0.00122 \text{ mm.} = \pm 0''.025.$$

γ LEPORIS ($5^h\ 40^m$; $-22°\ 28'$)

According to Burnham's General Catalogue, "this is a remarkable system from the large proper motion of the stars." This proper motion amounts to 0".47 per year. The principal star is of magnitude 3.80 and of type F8. The companion is Lalande 10931, and is of magnitude 6.4 and type K. The only determination of the parallax is due to Adams, who finds for the brighter star the value + 0".158, and for the fainter the parallax + 0".115. On account of the common parallax and common proper motion, these two stars undoubtedly form a physical system. The present series of plates were measured by Mr. Mitchell.

TABLE 1

PLATES OF γ LEPORIS, AND LALANDE 10931

No.	Date.	Hour Angle.	Observers.	Weight.
369	1914 Oct. 1	$-0^h.7$	M	0.8
411	Oct. 19	−0.3	G	0.7
863	1915 Feb. 9	+0.2	M	0.8
864	Feb. 9	+0.8	M	0.7
975	Mar. 2	+0.4	A	0.8
1845	Oct. 24	−0.5	G	0.8
1846	Oct. 24	−0.2	G	0.7
1924	Oct. 30	−0.8	M	0.8
1925	Oct. 30	−0.5	M	0.6
2364	1916 Feb. 3	+0.5	M	0.5*
2418	Feb. 20	0.0	M	0.7
2419	Feb. 20	+0.4	M	0.5*
2451	Mar. 9	+0.6	A	1.0
2452	Mar. 9	+0.9	A	1.0
3714	1917 Mar. 6	+0.3	L	1.0
3715	Mar. 6	+0.6	L	1.0
3729	Mar. 8	+0.5	L	1.0
3730	Mar. 8	+0.9	L	1.0

* One exposure.

Combining the parallaxes of the two stars, we have the parallax of the system to be:

$$+ 0''.143 \pm 0''.006.$$

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				Principal Star.	Companion.
	mm.	mm.	mm.		
1	0.11	−66.3	+ 0.3	+0.258	+0.275
2	.16	+12.3	−17.1	.346	.264
3	.12	+24.4	+25.1	.103	.213
4	.08	+29.6	− 8.3	+0.293	+0.248
Principal star	.18	− 1.7	− 5.7		
Companion	0.08	− 2.5	− 1.2		

TABLE 2

REDUCTIONS FOR γ LEPORIS, BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
369	−0.0018	0.8	+0.976	−474	−0.0006	−0″.01
411	− .0008	0.7	+ .858	−456	− .0031	− .05
863	− .0192	0.8	− .804	−343	− .0006	− .01
975	− .0215	0.8	− .960	−322	− .0002	.00
1845	− .0200	0.8	+ .812	− 86	+ .0023	+ .04
1846	− .0200	0.7	+ .812	− 86	+ .0023	+ .04
1924	− .0182	0.8	+ .747	− 80	− .0002	.00
1925	− .0172	0.6	+ .747	− 80	− .0012	− .02
2364	− .0365	0.5	− .736	+ 16	+ .0041	+ .06
2418	− .0355	0.7	− .899	+ 33	+ .0013	+ .02
2419	− .0343	0.5	− .899	+ 33	+ .0001	.00
2451	− .0359	1.0	− .986	+ 51	+ .0004	+ .01
2452	− .0363	1.0	− .986	+ 51	+ .0008	+ .02
3714	− .0456	1.0	− .978	+413	− .0030	− .06
3715	− .0487	1.0	− .978	+413	+ .0001	.00
3729	− .0484	1.0	− .983	+415	− .0004	− .01
3730	−0.0488	1.0	−0.983	+415	0.0000	0.00

According to Boss the proper motions in right ascension of the two stars are: for the brighter star $-0''.296$ per year, and for the fainter, $-0''.278$. The values found from the present photographs are $-0''.277$ and $-0''.274$ respectively.

The normal equations are:

$$13.7c + 3.342\mu - 5.1068\pi = -0.4134 \text{ mm.}$$
$$+ 121.4641\mu - 21.3025\pi = -0.6833 \text{ mm.}$$
$$+ 11.3326\pi = +0.2942 \text{ mm.}$$

from which:

$c = -0.02664$ mm.

$\mu = -0.00365$ mm. $= -0''.0759$, or $-0''.277$ per year.

$\pi = +0.00710$ mm. $= +\mathbf{0''.148 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00108 \text{ mm.} = \pm 0''.022.$$

TABLE 3

REDUCTIONS FOR γ LEPORIS, FAINTER STAR (LALANDE 10931)

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
369	−0.0354	1.0	+0.976	−374	+0.0002	0″.00
411	− .0354	1.0	+ .858	−356	− .0013	− .03
863	− .0520	1.0	− .804	−243	.0000	.00
864	− .0513	0.7	− .804	−243	− .0007	− .01
975	− .0559	0.7	− .960	−222	+ .0021	+ .04
1845	− .0519	0.9	+ .812	+ 14	+ .0016	+ .03
1846	− .0485	0.7	+ .812	+ 14	− .0018	− .03
1924	− .0520	0.9	+ .747	+ 20	+ .0010	+ .02
2364	− .0652	0.6	− .736	+116	+ .0008	+ .01
2418	− .0673	0.6	− .899	+133	+ .0011	+ .02
2419	− .0650	0.6	− .899	+133	− .0011	− .02
2451	− .0656	1.0	− .986	+151	− .0018	− .04
2452	−0.0676	1.0	−0.986	+151	+ .0002	0.00

The normal equations are:

$$10.7c - 7.269\mu - 1.7257\pi = -0.5770 \text{ mm.}$$
$$+ 47.7070\mu - 6.5000\pi = +0.1862 \text{ mm.}$$
$$+ 8.2292\pi = +0.1744 \text{ mm.}$$

from which:

$c = -0.00675$ mm.
$\mu = -0.00360$ mm. $= -0''.0748$, or $-0''.274$ per year.
$\pi = +0.05528$ mm. $= +0''.140 \pm 0''.007$.

Probable error of plate of unit weight

$$\pm 0.00085 \text{ mm.} = \pm 0''.018.$$

δ LEPORIS ($5^h\ 47^m$; $-20°\ 53'$)

The only value for the parallax of this star of 3.90 magnitude and K type is the spectroscopic result of Mt. Wilson with the

TABLE 1

PLATES OF δ LEPORIS

No.	Date.	Hour Angle.	Observers.	Weight.
3172	1916 Oct. 11	−0h6	M	0.9
3173	Oct. 11	−0.4	M	1.0
3376	Nov. 10	−0.5	A	0.6*
3377	Nov. 10	−0.3	A	1.0
4625	1917 Oct. 22	−0.6	Ds	0.7
4626	Oct. 22	−0.2	Ds	0.7
4633	Oct. 25	−0.7	Ds	0.5*
4634	Oct. 25	−0.1	Ds	0.6
5158	1918 Mar. 3	+0.3	M	0.8
5159	Mar. 3	+0.7	M	0.8
6247	1919 Jan. 13	+0.2	H	1.0
6248	Jan. 13	+0.6	H	1.0
6475	Feb. 6	0.0	D	1.0
6476	Feb. 6	+0.4	D	1.0
6583	Feb. 27	0.0	M	1.0
6584	Feb. 27	+0.3	M	1.0
8027	Nov. 8	+0.6	Ol	0.8
8072	Nov. 15	0.0	Ol	0.7
8073	Nov. 15	+0.5	Ol	0.7
8106	Nov. 19	−0.3	Ol	0.4*

* One exposure.

value + 0″.025. The total proper motion is 0″.696, of which + 0″.241 is in right ascension, according to Boss. Miss Hawes measured the McCormick plates and derived the relative parallax + 0″.019 ± 0″.010 with a proper motion in right ascension + 0″.239. In addition to the large proper motion, the star has a large radial velocity + 99 km. per second. (*Astrophysical Journal*, **49**, 179, 1919.)

TABLE 2

REDUCTIONS FOR δ LEPORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3172	−0.0391	0.9	+0.928	−609	−0.0002	0″.00
3173	− .0414	1.0	+ .928	−609	+ .0020	+ .04
3376	− .0422	0.6	+ .618	−579	+ .0035	+ .06
3377	− .0350	1.0	+ .618	−579	− .0037	− .08
4625	− .0276	0.7	+ .842	−233	.0000	.00
4626	− .0268	0.7	+ .842	−233	− .0008	− .01
4633	− .0275	0.5	+ .812	−230	.0000	.00
4634	− .0280	0.6	+ .812	−230	+ .0005	+ .01
5158	− .0208	0.8	− .960	−101	− .0042	− .08
5159	− .0278	0.8	− .960	−101	+ .0028	+ .05
6247	− .0144	1.0	− .427	+215	− .0002	.00
6248	− .0166	1.0	− .427	+215	+ .0020	+ .04
6475	− .0147	1.0	− .756	+239	+ .0006	+ .01
6476	− .0135	1.0	− .756	+239	− .0006	− .01
6583	− .0152	1.0	− .937	+260	+ .0016	+ .03
6584	− .0126	1.0	− .937	+260	− .0010	− .02
8027	− .0054	0.8	+ .654	+514	+ .0012	+ .02
8072	− .0026	0.7	+ .557	+521	− .0015	− .02
8073	− .0023	0.7	+ .557	+521	− .0018	− .03
8106	−0.0051	0.4	+0.499	+525	+0.0011	+0.01

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	−41.6	+21.2	+0.185
2	.11	−40.8	−29.2	.242
3	.16	+ 7.3	− 2.4	.201
4	.14	+33.9	−30.7	.227
5	.15	+41.2	+41.1	+0.145
Parallax star	0.16	− 2.5	− 4.7	

The normal equations are:

$$16.2c - 0.457\mu + 0.5506\pi = - 0.3412 \text{ mm.}$$
$$+ 243.5092\mu - 22.2349\pi = + 0.7568 \text{ mm.}$$
$$+ 9.5795\pi = - 0.0730 \text{ mm.}$$

from which:

$c = - 0.02100$ mm.
$\mu = + 0.00315$ mm. $= + 0''.0655$, or $+ 0''.239$ per year.
$\pi = + 0.00089$ mm. $= + \mathbf{0''.019 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

χ ORIONIS ($5^h\ 48^m$; $+20°\ 15'$)

According to the investigations of H. C. Plummer (*Monthly Notices, R. A. S.*, **76**, 134, 1915), this star which is of 4.62 magnitude and F8 type, is a member of an extended Ursa Major group, and on this assumption should have an absolute parallax of $+ 0''.135$. Mr. Alden measured the McCormick plates, and found a relative parallax of $+ 0''.105 \pm 0''.006$, so that the value of the absolute parallax is $+ 0''.110 \pm 0''.006$, a result which seems to substantiate the claim of Plummer. By photography Allegheny finds the relative parallax $+ 0''.096 \pm 0''.010$, and Mt. Wilson by the spectrograph the absolute value $+ 0''.100$. The annual proper motion in right ascension from the photographs is $- 0''.145$, while the value from Boss is $- 0''.186$.

TABLE 1

PLATES OF χ ORIONIS

No.	Date.	Hour Angle.	Observers.	Weigbt.
3118	1916 Sept. 30	−0ʰ2	M	1.0
3210	Oct. 17	−0.8	L	1.0
3211	Oct. 17	−0.5	L	0.6*
3312	Oct. 31	−0.9	L	1.0
3313	Oct. 31	−0.6	L	1.0
3647	1917 Feb. 7	−0.5	Ol	0.8
3648	Feb. 7	−0.1	Ol	0.9
3735	Mar. 9	+0.6	L	1.0
3736	Mar. 9	+0.9	L	1.0
4496	Oct. 1	−0.1	B	1.0
4497	Oct. 1	+0.2	B	0.9
4509	Oct. 2	+0.1	A	0.9
4510	Oct. 2	+0.4	A	1.0
4530	Oct. 6	0.0	M	0.8
4531	Oct. 6	+0.3	M	0.8
4986	1918 Jan. 22	+0.5	M	1.0
5024	Feb. 7	+0.3	A	1.0
5025	Feb. 7	+0.7	A	1.0
5177	Mar. 7	+0.5	A	0.9
5189	Mar. 11	+0.4	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−54.7	+ 8.1	+0.2787
2	.12	+ 2.3	−28.2	.2169
3	.11	+20.0	−12.7	.2283
4	.18	+32.4	+32.8	+0.2761
Parallax star	0.14	− 1.2	+ 2.3	

TABLE 2

REDUCTIONS FOR χ ORIONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3118	−0.0023	1.0	+0.985	−270	−0.0010	−0″.02
3210	− .0018	1.0	+ .887	−253	− .0023	− .05
3211	− .0046	0.6	+ .887	−253	+ .0005	+ .01
3312	− .0056	1.0	+ .749	−239	+ .0005	+ .01
3313	− .0053	1.0	+ .749	−239	+ .0002	.00
3647	− .0149	0.8	− .768	−140	+ .0002	.00
3648	− .0144	0.9	− .768	−140	− .0003	− .01
3735	− .0173	1.0	− .982	−110	+ .0010	+ .02
3736	− .0180	1.0	− .982	−110	+ .0016	+ .03
4496	− .0102	1.0	+ .982	+ 96	− .0001	.00
4497	− .0114	0.9	+ .982	+ 96	+ .0011	+ .02
4509	− .0080	0.9	+ .978	+ 97	− .0024	− .05
4510	− .0140	1.0	+ .978	+ 97	+ .0036	+ .07
4530	− .0108	0.8	+ .961	+101	+ .0003	.00
4531	− .0111	0.8	+ .961	+101	+ .0006	+ .01
4986	− .0184	1.0	− .560	+209	− .0019	− .04
5024	− .0210	1.0	− .765	+225	− .0006	− .01
5025	− .0206	1.0	− .765	+225	− .0010	− .02
5177	− .0222	0.9	− .974	+253	− .0010	− .02
5189	−0.0248	1.0	−0.986	+257	+0.0014	+0.03

The normal equations are:

$$18.6c + 0.612\mu + 1.9416\pi = -0.2419 \text{ mm.}$$
$$+ 66.7374\mu - 10.0602\pi = -0.1868 \text{ mm.}$$
$$+ 14.7196\pi = +0.0677 \text{ mm.}$$

from which:

$c = -0.01347$ mm.

$\mu = -0.00191$ mm. $= -0''.0398$, or $-0''.145$ per year.

$\pi = +0.00507$ mm. $= +\mathbf{0''.105 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00101 \text{ mm.} = \pm 0''.021.$$

δ AURIGÆ ($5^h\ 51^m$; $+54°\ 17'$)

This star is of Ko type, of magnitude 3.88, and of total proper motion 0″.15. Three values of the parallax have been published, the meridian circle result of Abetti who finds the parallax + 0″.107 ± 0″.033, the photographic value with the Yerkes refractor + 0″.018 ± 0″.013, and the spectroscopic value of Adams with the parallax + 0″.021. The present plates were measured by Mr. Alden who finds the proper motion in right ascension to be + 0″.078 while the value of Boss is + 0″.086.

TABLE 1

PLATES OF δ AURIGÆ

No.	Date.	Hour Angle.	Observers.	Weight.
417	1914 Oct. 21	−0^{h}6	M	0.8
441	Oct. 30	−0.4	A	0.6*
629	Nov. 23	−0.5	G	0.8
922	1915 Feb. 20	−0.3	A	0.8
1810	Oct. 10	−0.2	A	1.0
1874	Oct. 27	−0.6	A	1.0
1875	Oct. 27	−0.1	A	1.0
1951	Nov. 2	−0.7	A	1.0
1952	Nov. 2	−0.4	A	1.0
2386	1916 Feb. 8	−0.4	M	0.8
2390	Feb. 9	−0.4	G	1.0
2397	Feb. 10	−0.5	A	1.0
2398	Feb. 10	−0.1	A	1.0
4552	1917 Oct. 9	−0.2	A	1.0
4587	Oct. 15	−0.8	B	0.9
4588	Oct. 15	−0.4	B	0.8
4647	Oct. 30	−0.2	B	1.0
5010	1918 Jan. 31	−0.8	A	1.0
5011	Jan. 31	−0.4	A	1.0
5062	Feb. 11	−0.8	A	1.0
5063	Feb. 11	−0.4	A	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR δ AURIGÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
417	+0.0005	0.8	+0.864	−624	−0.0005	−0″.01
441	− .0020	0.6	+ .775	−615	+ .0021	+ .03
629	+ .0024	0.8	+ .452	−591	− .0020	− .04
922	+ .0024	0.8	− .881	−502	− .0008	− .01
1810	+ .0017	1.0	+ .946	−270	+ .0019	+ .04
1874	+ .0037	1.0	+ .809	−253	+ .0001	.00
1875	+ .0034	1.0	+ .809	−253	+ .0004	+ .01
1951	+ .0041	1.0	+ .744	−247	− .0002	.00
1952	+ .0038	1.0	+ .744	−247	+ .0001	.00
2386	+ .0049	0.8	− .762	−149	+ .0003	+ .01
2390	+ .0052	1.0	− .774	−148	.0000	.00
2397	+ .0071	1.0	− .784	−147	− .0019	− .04
2398	+ .0039	1.0	− .784	−147	+ .0013	+ .03
4552	+ .0146	1.0	+ .949	+460	− .0034	− .07
4587	+ .0104	0.9	+ .910	+466	+ .0008	+ .02
4588	+ .0125	0.8	+ .910	+466	− .0012	− .02
4647	+ .0098	1.0	+ .772	+481	+ .0016	+ .03
5010	+ .0106	1.0	− .672	+574	+ .0021	+ .04
5011	+ .0123	1.0	− .672	+574	+ .0004	+ .01
5062	+ .0132	1.0	− .800	+585	− .0004	− .01
5063	+0.0135	1.0	−0.800	+585	−0.0007	−0.01

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−46.0	−22.6	+0.4287
2	0.12	+11.2	−17.2	.3607
3	0.19	+34.8	+39.8	+0.2106
Parallax star	0.14	− 8.4	− 7.5	

The normal equations are:

$$19.5c + 4.774\mu + 2.2374\pi = + 0.1332 \text{ mm.}$$
$$+ 358.0811\mu - 13.5229\pi = + 0.4043 \text{ mm.}$$
$$+ 12.4333\pi = - 0.0015 \text{ mm.}$$

from which:

$c = + 0.00660$ mm.
$\mu = + 0.00103$ mm. $= + 0''.0215$, or $+ 0''.078$ per year.
$\pi = - 0.00019$ mm. $= - \mathbf{0''.004 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00097 \text{ mm.} = \pm 0''.020.$$

η LEPORIS ($5^h\ 52^m$; $-14°\ 11'$)

This star has had its parallax determined by Adams by the spectroscopic method with the absolute value $+ 0''.050$. The star is of magnitude 3.77, of spectral type F5, and of total proper motion $0''.138$. Mr. Olivier measured the photographs and derived a relative parallax $+ 0''.031 \pm 0''.010$, and a proper motion in right ascension $- 0''.012$ while the corresponding value from Boss is $- 0''.041$.

TABLE 1

PLATES OF η LEPORIS

No.	Date.	Hour Angle.	Observers.	Weight.
1057	1915 Mar. 14	+0^{h}4	M	0.7
1067	Mar. 17	+0.7	A	0.7
1068	Mar. 17	+0.7	A	1.0
1741	Sept. 22	−0.8	Ol	0.7
1821	Oct. 11	+0.7	Ol	0.7
1862	Oct. 25	−0.4	Ol	0.6*
1863	Oct. 25	0.0	Ol	0.8
2046	Nov. 22	0.0	Ol	0.7
2488	1916 Mar. 16	+0.9	A	1.0
2489	Mar. 16	+1.3	A	1.0
3132	Oct. 1	−0.6	L	0.9
3274	Oct. 25	−0.3	L	0.7
3291	Oct. 27	−1.0	M	1.0
3292	Oct. 27	−0.5	M	0.9
3766	1917 Mar. 19	+0.8	Ol	0.9
3767	Mar. 19	+0.2	Ol	0.9
3778	Mar. 20	+1.0	M	0.7
4572	Oct. 13	0.0	B	0.9
4573	Oct. 13	+0.4	B	0.9
4617	Oct. 21	−0.1	B	1.0
4618	Oct. 21	+0.4	B	1.0
5116	1918 Feb. 22	+0.4	Ol	0.5*
5117	Feb. 22	+0.9	Ol	0.7
5172	Mar. 5	+0.8	Ol	0.9
5173	Mar. 5	+1.4	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−13.6	−17.3	+0.2607
2	.15	−14.3	−38.3	.1658
3	.12	− 5.6	+21.0	.3879
4	.14	+33.5	+34.6	+0.1856
Parallax star	0.15	− 1.8	+ 3.7	

TABLE 2

REDUCTIONS FOR η LEPORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual = (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1057	+0.0057	0.7	−0.991	−580	−0.0002	0″.00
1067	+ .0042	0.7	− .995	−577	+ .0013	+ .02
1068	+ .0046	1.0	− .995	−577	+ .0009	+ .02
1741	+ .0105	0.7	+1.003	−388	− .0024	− .04
1821	+ .0126	0.7	+0.940	−369	− .0046	− .08
1862	+ .0064	0.6	+ .829	−365	+ .0014	+ .02
1863	+ .0057	0.8	+ .829	−365	+ .0021	+ .04
2046	+ .0030	0.7	+ .470	−327	+ .0042	+ .07
2488	+ .0050	1.0	− .994	−212	− .0001	.00
2489	+ .0077	1.0	− .994	−212	− .0028	− .06
3132	+ .0087	0.9	+ .984	− 13	− .0012	− .02
3274	+ .0052	0.7	+ .821	+ 11	+ .0020	+ .04
3291	+ .0095	1.0	+ .801	+ 13	− .0023	− .05
3292	+ .0132	0.9	+ .801	+ 13	− .0060	− .12
3766	− .0011	0.9	− .996	+156	+ .0054	+ .11
3767	+ .0027	0.9	− .996	+156	+ .0016	+ .03
3778	+ .0024	0.7	− .996	+157	+ .0019	+ .03
4572	+ .0031	0.9	+ .923	+364	+ .0037	+ .07
4573	+ .0027	0.9	+ .923	+364	+ .0041	+ .08
4617	+ .0052	1.0	+ .861	+372	+ .0015	+ .03
4618	+ .0076	1.0	+ .861	+372	− .0009	− .02
5116	+ .0010	0.5	− .899	+496	+ .0029	+ .04
5117	+ .0060	0.7	− .899	+496	− .0021	− .04
5172	+ .0062	0.9	− .964	+507	− .0024	− .05
5173	+0.0090	0.9	−0.964	+507	−0.0052	−0.10

The normal equations are:

$$20.7c + 2.377\mu - 0.4619\pi = + 0.1233 \text{ mm.}$$
$$+ 268.8191\mu + 2.0934\pi = - 0.0258 \text{ mm.}$$
$$+ 17.4871\pi = + 0.0227 \text{ mm.}$$

from which:

$c = + 0.00601$ mm.
$\mu = - 0.00016$ mm. $= - 0''.0033$, or $- 0''.012$ per year.
$\pi = + 0.00147$ mm. $= + \mathbf{0''.031 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00196 \text{ mm.} = \pm 0''.041.$$

β AURIGÆ ($5^h\ 52^m$; $+44°\ 56'$)

β Aurigæ is a very interesting spectroscopic binary discovered by Miss Maury from photographs taken at Harvard. Several determinations have been made of the spectroscopic orbit by Rambaut, Vogel, Ludendorff and Belopolsky (*Lick Observatory Bulletin*, **6**, 23, 1910). The star is of Ap type, of magnitude 2.07, and of small annual proper motion $0''.06$. The period of the spectroscopic binary is 3.96 days. According to Hertzsprung (*Astrophysical Journal*, **30**, 135, 1909), β Aurigæ is a member on an extended Ursa Major group and should have an absolute parallax of $+ 0''.030$. The star is an eclipsing binary, and according to Shapley (*Mt. Wilson Contributions*, 156) should have a parallax $+ 0''.030$. The parallax of the star has been many times determined, but with results that are not very accordant. Pritchard by photography obtained the parallax $+ 0''.062 \pm 0''.024$; Kostinsky and Tikhoff derived two different values, $- 0''.030 \pm 0''.014$, and $+ 0''.015 \pm 0''.018$; Flint by meridian circle found $\pi = + 0''.034 \pm 0''.020$; while Jewdokimov also with meridian circle found $+ 0''.141 \pm 0''.062$. Mr. Alden measured the McCormick plates, and found a relative parallax of $+ 0''.026 \pm 0''.009$, with a proper motion in right ascension amounting to $- 0''.076$ per year, while the value from Boss is $- 0''.047$.

TABLE 1

PLATES OF β AURIGÆ

No.	Date.	Hour Angle.	Observers.	Weight.
323	1914 Sept. 26	−1h0	M	0.9
345	Sept. 28	−0.4	G	0.9
364	Sept. 30	−0.4	A	0.7
2362	1916 Feb. 3	−0.6	M	0.8
2363	Feb. 3	−0.2	M	1.0
2425	Feb. 26	−0.1	A	1.0
2450	Mar. 9	−0.1	M	0.8
3161	Oct. 10	−0.5	A	0.8
3162	Oct. 10	−0.2	A	0.5*
3217	Oct. 19	−0.4	L	1.0
3218	Oct. 19	−0.1	L	1.0
3293	Oct. 27	0.0	M	1.0
3749	1917 Mar. 10	−0.1	M	0.7
3750	Mar. 10	−0.1	A	0.6*
3751	Mar. 11	0.0	M	0.7
3752	Mar. 12	0.0	Ol	0.7
4507	Oct. 2	−1.0	A	1.0
4508	Oct. 2	−0.5	A	1.0
4521	Oct. 5	−0.6	A	1.0
4522	Oct. 5	−0.3	A	0.9
5022	1918 Feb. 7	−0.6	A	1.0
5023	Feb. 7	−0.2	A	1.0
5047	Feb. 10	−0.7	M	0.5*
5092	Feb. 14	−0.7	A	0.9
5176	Mar. 7	0.0	A	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−32.2	−22.9	+0.2721
2	.13	−11.5	+46.5	.2412
3	.25	+16.2	+ 6.2	.2405
4	.19	+27.5	−29.8	+0.2462
Parallax star	0.26	− 0.9	− 0.9	

TABLE 2

REDUCTIONS FOR β AURIGÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
323	−0.0062	0.9	+0.998	−800	+0.0005	+0″.01
345	− .0078	0.9	+ .994	−798	+ .0021	+ .04
364	− .0070	0.7	+ .989	−796	+ .0012	+ .02
2362	− .0102	0.8	− .702	−305	− .0025	− .05
2363	− .0164	1.0	− .702	−305	+ .0037	+ .08
2425	− .0144	1.0	− .922	−282	+ .0012	+ .02
2450	− .0095	0.8	− .980	−270	− .0039	− .07
3161	− .0107	0.8	+ .942	− 55	− .0025	− .05
3162	− .0098	0.5	+ .942	− 55	− .0034	− .05
3217	− .0148	1.0	+ .878	− 46	+ .0015	+ .03
3218	− .0088	1.0	+ .878	− 46	− .0045	− .09
3293	− .0111	1.0	+ .803	− 38	− .0024	− .05
3749	− .0154	0.7	− .982	+ 96	− .0017	− .03
3750	− .0157	0.6	− .982	+ 96	− .0014	− .02
3751	− .0203	0.7	− .985	+ 97	+ .0032	+ .06
3752	− .0167	0.7	− .987	+ 98	− .0004	− .01
4507	− .0188	1.0	+ .982	+302	+ .0021	+ .04
4508	− .0162	1.0	+ .982	+302	− .0005	− .01
4521	− .0194	1.0	+ .970	+305	+ .0027	+ .06
4522	− .0177	0.9	+ .970	+305	+ .0010	+ .02
5022	− .0154	1.0	− .755	+430	− .0047	− .10
5023	− .0226	1.0	− .755	+430	+ .0025	+ .05
5047	− .0218	0.5	− .788	+433	+ .0016	+ .02
5092	− .0236	0.9	− .828	+437	+ .0033	+ .07
5176	−0.0200	0.7	−0.971	+458	−0.0006	−0.01

The normal equations are:

$$21.1c - 0.087\mu + 1.1202\pi = -0.3128 \text{ mm.}$$
$$+ 307.4249\mu - 18.6384\pi = -0.3274 \text{ mm.}$$
$$+ 17.3745\pi = +0.0235 \text{ mm.}$$

from which:

$c = -0.01489$ mm.

$\mu = -0.00099$ mm. $= -0''.0207$, or $-0''.076$ per year.

$\pi = +0.00124$ mm. $= +\mathbf{0''.026 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00170 \text{ mm.} = \pm 0''.035.$$

η GEMINORUM ($6^h\ 8^m$; $+22°\ 32'$)

This is a variable star of Ma type, and with a range of magnitude from 3.2 to 4.2. Reese (*Lick Observatory Bulletin*, **1** 158, 1902) finds it to be a spectroscopic binary with long period Mt. Wilson by the spectroscope finds the parallax + 0″.012

TABLE 1

PLATES OF η GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
456	1914 Oct. 31	−0h1	M	0.9
962	1915 Mar. 1	−0.3	G	0.9
963	Mar. 1	+0.2	M, G	1.0
1894	Oct. 28	−0.2	Ol	0.9
1895	Oct. 28	−0.2	Ol	0.6*
1959	Nov. 3	+0.1	G	0.8
2044	Nov. 21	−1.0	G	0.7
2426	1916 Feb. 26	+0.1	A	0.5*
2439	Mar. 4	0.0	A	0.9
2440	Mar. 4	+0.5	A	1.0
2494	Mar. 17	+0.3	Ol, G	0.9
2517	Mar. 22	+1.0	Ol	0.7*
4721	1917 Nov. 6	−0.8	Ds	0.9
4759	Nov. 10	−0.2	Ds	0.9
4827	Dec. 1	−0.3	B	0.8
4828	Dec. 1	+0.1	B	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−54.8	− 2.2	+0.1767
2	.12	−36.7	+23.0	.1840
3	.12	+18.5	−36.2	.2085
4	.16	+45.2	−30.0	.2197
5	.14	+27.8	+45.4	+0.2111
Parallax star	0.15	+ 3.2	− 0.7	

Russell by photography derives the parallax of + 0″.034 ± 0″.025, and Allegheny the value + 0″.016 ± 0″.008. The total proper motion is 0″.065, while the value in right ascension from Boss is −0″.062. Mr. Olivier measured the McCormick plates and derived the value of proper motion in right ascension of − 0″.045.

TABLE 2

REDUCTIONS FOR η GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
456	−0.0035	0.9	+0.805	−542	−0.0008	−0″.01
962	− .0043	0.9	− .919	−420	− .0006	− .01
963	− .0023	1.0	− .919	−420	− .0026	− .05
1894	− .0099	0.9	+ .837	−179	+ .0035	+ .07
1895	− .0036	0.6	+ .837	−179	− .0028	− .05
1959	− .0081	0.8	+ .776	−173	+ .0017	+ .03
2044	− .0057	0.7	+ .544	−155	− .0008	− .01
2426	− .0111	0.5	− .896	− 58	+ .0040	+ .06
2439	− .0052	0.9	− .942	− 51	− .0019	− .04
2440	− .0084	1.0	− .942	− 51	+ .0013	+ .03
2494	− .0077	0.9	− .991	− 38	+ .0005	+ .01
2517	− .0094	0.7	− .997	− 32	+ .0022	+ .04
4721	− .0114	0.9	+ .736	+561	+ .0006	+ .01
4759	− .0098	0.9	+ .689	+565	− .0010	− .02
4827	− .0078	0.8	+ .382	+586	− .0031	− .06
4828	−0.0118	0.9	+0.382	+586	+0.0009	+0.02

The normal equations are:

$$13.3c + 0.259\mu - 0.6602\pi = - 0.0989 \text{ mm.}$$
$$+ 185.1335\mu + 12.2553\pi = - 0.1114 \text{ mm.}$$
$$+ 8.7576\pi = - 0.0027 \text{ mm.}$$

from which:

$c = - 0.00743$ mm.

$\mu = - 0.00059$ mm. $= - 0''.0122$, or $- 0''.045$ per year.

$\pi = - 0.00004$ mm. $= - \mathbf{0''.001 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00136 \text{ mm.} = \pm 0''.028.$$

2 LYNCIS ($6^h\ 10^m$; $+59°\ 2'$)

Abetti with the meridian circle has found the parallax of this star to be $+ 0''.109 \pm 0''.025$, the star being of magnitude 4.42, of type A, and of small total proper motion, $0''.022$. Mr. Olivier measured the plates, and found a relative parallax $+ 0''.021 \pm 0''.011$ with a proper motion in right ascension $+ 0''.005$ while the corresponding value from Boss is $- 0''.005$.

TABLE 1

PLATES OF 2 LYNCIS

No.	Date.	Hour Angle.	Observers.	Weight.
3235	1916 Oct. 21	$-0^h.9$	M	0.9
3349	Nov. 5	−0.6	L	1.0
3389	Nov. 16	−1.2	M	0.9
3390	Nov. 16	−0.7	M	0.9
5096	1918 Feb. 17	−0.5	M	0.9
5097	Feb. 17	−0.1	M	0.8
5144	Feb. 28	−0.7	A	0.9
5145	Feb. 28	−0.1	A	0.9
5912	Nov. 7	−0.5	C, F	0.8
5913	Nov. 7	0.0	C, F	0.8
5936	Nov. 11	−0.4	C	0.9
5980	Nov. 14	−0.4	H	1.0
6245	1919 Jan. 13	−1.5	H	0.9
6246	Jan. 13	−1.2	H	1.0
6573	Feb. 2	−1.0	M	0.8
6574	Feb. 2	−0.6	M	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−44.0	+26.6	+0.2224
2	.13	−21.6	+11.0	.2358
3	.20	+23.1	−53.7	.2543
4	.15	+42.5	+16.1	+0.2875
Parallax star	0.18	+ 3.2	− 0.5	

TABLE 2

REDUCTIONS FOR 2 LYNCIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3235	+0.0034	0.9	+0.896	−523	−0.0016	−0″.03
3349	+ .0036	1.0	+ .751	−518	− .0019	− .04
3389	− .0011	0.9	+ .612	−497	+ .0027	+ .05
3390	− .0003	0.9	+ .612	−497	+ .0019	+ .04
5096	+ .0028	0.9	− .816	− 39	− .0023	− .05
5097	+ .0023	0.8	− .816	− 39	− .0018	− .03
5144	− .0020	0.9	− .910	− 28	+ .0024	+ .05
5145	+ .0006	0.9	− .910	− 28	− .0002	.00
5912	+ .0020	0.8	+ .733	+224	+ .0002	.00
5913	+ .0040	0.8	+ .733	+224	− .0018	− .03
5936	+ .0004	0.9	+ .684	+228	+ .0018	+ .04
5980	+ .0030	1.0	+ .645	+231	− .0009	− .02
6245	+ .0030	0.9	− .336	+291	− .0018	− .04
6246	− .0015	1.0	− .336	+291	+ .0027	+ .06
6573	− .0011	0.8	− .893	+335	+ .0018	+ .03
6574	+0.0020	1.0	−0.893	+335	−0.0013	−0.03

The normal equations are:

$$14.4c - 0.495\mu - 0.1786\pi = + 0.0190 \text{ mm.}$$
$$+ 150.6440\mu - 14.3049\pi = - 0.0040 \text{ mm.}$$
$$+ 7.9299\pi = + 0.0066 \text{ mm.}$$

from which:

$c = + 0.00133$ mm.

$\mu = + 0.00007$ mm. $= + 0''.0015$, or $+ 0''.005$ per year.

$\pi = + 0.00099$ mm. $= + \mathbf{0''.021 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00130 \text{ mm.} = \pm 0''.027.$$

BOSS 1599 ($6^h\ 15^m$; $-2°\ 54'$)

This star is of magnitude 5.2, of spectral type Ma, and of total proper motion 0″.009. Adams has found a radial velocity + 48.3 km. per second, and a spectroscopic parallax + 0″.012. Mr. Olivier measured the photographs and derived a relative parallax of − 0″.009 ± 0″.010, with a proper motion in right ascension − 0″.012 while the corresponding value from Boss is − 0″.009.

TABLE 1

PLATES OF BOSS 1599

No.	Date.	Hour Angle.	Observers.	Weight.
3163	1916 Oct. 10	+0h1	A	1.0
3360	Nov. 7	−0.6	L	0.9
3361	Nov. 7	−0.3	L	1.0
3423	Nov. 21	−1.0	L	0.6*
5050	1918 Feb. 10	+0.5	M	1.0
5051	Feb. 10	+0.9	M	1.0
5193	Mar. 15	+1.0	Ol	0.9
5885	Nov. 5	−0.7	M	1.0
5886	Nov. 5	−0.3	M	1.0
6258	1919 Jan. 15	+0.6	D	0.9
6288	Jan. 20	−0.5	F	0.9
6289	Jan. 20	0.0	F	0.7*
6321	Jan. 23	+0.6	D	0.7
6477	Feb. 6	+0.6	D	1.0
6478	Feb. 6	+1.0	D	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−25.2	−25.1	+0.2248
2	.13	−14.8	+33.8	.4656
3	.13	+40.0	− 8.7	+0.3096
Parallax star	0.13	− 0.2	+ 7.4	

TABLE 2

REDUCTIONS FOR BOSS 1599

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3163	+0.0099	1.0	+0.967	−542	+0.0009	+0″.02
3360	+ .0128	0.9	+ .736	−514	− .0019	− .04
3361	+ .0093	1.0	+ .736	−514	+ .0016	+ .03
3423	+ .0122	0.6	+ .552	−500	− .0013	− .02
5050	+ .0097	1.0	− .732	− 54	+ .0011	+ .02
5051	+ .0100	1.0	− .732	− 54	+ .0008	+ .02
5193	+ .0130	0.9	− .982	− 21	− .0022	− .04
5885	+ .0110	1.0	+ .765	+214	− .0013	− .03
5886	+ .0086	1.0	+ .765	+214	+ .0011	+ .02
6258	+ .0108	0.9	− .358	+285	− .0007	− .01
6288	+ .0126	0.9	− .437	+290	− .0025	− .05
6289	+ .0106	0.7	− .437	+290	− .0005	− .01
6321	+ .0080	0.7	− .484	+293	+ .0021	+ .04
6477	+ .0084	1.0	− .680	+307	+ .0018	+ .04
6478	+0.0100	1.0	−0.680	+307	+0.0002	0.00

The normal equations are:

$$13.6c + 0.221\mu - 0.8414\pi = + 0.1415 \text{ mm.}$$
$$+ 149.9812\mu - 17.9484\pi = - 0.0134 \text{ mm.}$$
$$+ 6.7668\pi = - 0.0089 \text{ mm.}$$

from which:

$c = + 0.01038$ mm.

$\mu = - 0.00016$ mm. $= - 0''.0033$, or $- 0''.012$ per year.

$\pi = - 0.00044$ mm. $= - \mathbf{0''.009 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00105 \text{ mm.} = \pm 0''.022.$$

μ GEMINORUM ($6^h\ 16^m$; $+22°\ 33'$)

This is a star of Ma type, of magnitude 3.19, and of total proper motion 0″.13. The parallax of Allegheny Observatory gives the value + 0″.030 ± 0″.008, while Mt. Wilson by the

TABLE 1

PLATES OF μ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
501	1914 Nov. 4	−0ʰ1	M	1.0
617	Nov. 22	−0.1	A	1.0
887	1915 Feb. 17	−0.5	G	0.8
888	Feb. 17	+0.1	G	0.8
909	Feb. 19	−0.3	G	0.6
910	Feb. 19	+0.1	G	0.7
1086	Mar. 19	+0.3	M, G	0.9
1791	Oct. 8	−0.3	G	0.7*
1792	Oct. 8	+0.2	G	0.8
1847	Oct. 24	−0.4	G	0.7
1848	Oct. 24	−0.1	G	0.6
1910	Oct. 29	−1.1	G	0.7
1911	Oct. 29	−0.6	G	0.9
2406	1916 Feb. 14	+0.9	G	0.6*
2407	Feb. 14	+1.3	G	0.5
2447	Mar. 8	+0.2	G	0.7
2476	Mar. 15	+0.2	G	0.8
2477	Mar. 15	+0.6	G	0.8
3186	Oct. 12	−0.8	L	0.8
3187	Oct. 12	−0.4	L	0.9
3212	Oct. 17	−0.4	L	1.0
3226	Oct. 20	0.0	L	0.9
3808	1917 Mar. 25	+0.8	M	0.8
4548	Oct. 7	−0.4	Ol	0.8
4574	Oct. 13	+0.6	B	0.9
4871	Dec. 14	0.0	Ol	0.9
4872	Dec. 14	+0.6	Ds	1.0

* One exposure.

spectroscope finds + 0″.013. The McCormick value of the proper motion in right ascension is + 0″.043 while the value from Boss is + 0″.061. Mr. Graham measured the first eighteen plates of the series. Mr. Olivier measured all of the plates with the exception of plates 910 and 1848.

TABLE 2

REDUCTIONS FOR μ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
501	−0.0038	1.0	+0.781	−490	+0.0010	+0″.02
617	− .0064	1.0	+ .551	−472	+ .0035	+ .07
887	+ .0012	0.8	− .801	−385	− .0043	− .08
888	− .0030	0.8	− .801	−385	− .0001	.00
909	− .0025	0.6	− .821	−383	− .0006	− .01
910	− .0026	0.7	− .821	−383	− .0005	− .01
1086	+ .0004	0.9	− .990	−355	− .0034	− .07
1791	− .0012	0.7	+ .980	−152	+ .0004	+ .01
1792	− .0003	0.8	+ .980	−152	− .0005	− .01
1847	− .0023	0.7	+ .888	−136	+ .0015	+ .03
1848	+ .0012	0.6	+ .888	−136	− .0020	− .03
1910	+ .0018	0.7	+ .844	−131	− .0026	− .04
1911	− .0038	0.9	+ .844	−131	+ .0030	+ .06
2406	− .0014	0.6	− .767	− 23	+ .0004	+ .01
2407	− .0025	0.5	− .767	− 23	+ .0015	+ .02
2447	− .0046	0.7	− .954	0	+ .0036	+ .06
2476	− .0023	0.8	− .982	+ 7	+ .0013	+ .02
2477	− .0022	0.8	− .982	+ 7	+ .0012	+ .02
3186	+ .0010	0.8	+ .960	+218	+ .0003	+ .01
3187	+ .0055	0.9	+ .960	+218	− .0042	− .08
3212	+ .0020	1.0	+ .932	+223	− .0007	− .01
3226	+ .0007	0.9	+ .912	+226	+ .0006	+ .01
3808	+ .0015	0.8	− .997	+382	− .0003	− .01
4548	+ .0027	0.8	+ .982	+578	+ .0006	+ .01
4574	+ .0059	0.9	+ .956	+584	− .0025	− .05
4871	+ .0029	0.9	+ .194	+646	+ .0004	+ .01
4872	+0.0014	1.0	+0.194	+646	+0.0019	+0.04

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.24	−45.8	+ 6.5	+0.3519
2	.14	−16.0	+36.4	.2311
3	.16	+20.2	−46.5	.2747
4	.10	+41.6	+ 3.6	+0.1423
Parallax star	0.20	− 8.4	− 1.6	

The normal equations are:

$$21.6c + 2.941\mu + 3.5860\pi = - 0.0066 \text{ mm.}$$
$$+ 275.1326\mu + 16.6590\pi = + 0.1641 \text{ mm.}$$
$$+ 15.7757\pi = + 0.0163 \text{ mm.}$$

from which:

$c = - 0.00047$ mm.
$\mu = + 0.00057$ mm. $= + 0''.0118$, or $+ 0''.043$ per year.
$\pi = + 0.00054$ mm. $= + \mathbf{0''.011 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00135 \text{ mm.} = \pm 0''.028.$$

β CANIS MAJORIS ($6^h\ 18^m$; $-17°\ 54'$)

This is a B-type star, of magnitude 1.99, and of very small total proper motion which is less than $0''.01$ per year. From these considerations one would naturally expect a small parallax. Flint by the meridian circle finds the parallax of $+ 0''.163 \pm 0''.031$. Henroteau (*Lick Observatory Bulletin*, 311) finds this star to be an interesting spectrospocic binary of very short period $0.^d25$. The McCormick plates were measured by Mr. Mitchell who finds the proper motion in right ascension of $+ 0''.024$, while the value of Boss is $- 0''.006$. The parallax from the present photographs is $+ 0''.007 \pm 0''.010$.

TABLE 1

PLATES OF β CANIS MAJORIS

No.	Date.	Hour Angle.	Observers.	Weight.
937	1915 Feb. 22	$-0^h.2$	M	0.7
1036	Mar. 12	0.0	A	0.9
1037	Mar. 12	+0.4	A	1.0
1111	Mar. 27	+1.1	A	1.0
1876	Oct. 27	0.0	A	1.0
1926	Oct. 30	−0.6	M	0.8
1927	Oct. 30	−0.3	M	0.8
2103	Dec. 2	−0.5	M	0.8
2104	Dec. 2	−0.1	M	0.8
2420	1916 Feb. 20	+0.2	M	0.8
2421	Feb. 20	+0.6	M	0.6*
2430	Feb. 29	+0.5	A	1.0
2456	Mar. 11	+0.1	A	1.0
2457	Mar. 11	+0.4	A	1.0
4731	1917 Nov. 7	−1.0	B	0.8
4732	Nov. 7	−0.7	B	0.8
4744	Nov. 9	−0.6	B	0.8
4745	Nov. 9	−0.2	B	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−38.3	−20.9	+0.280
2	.12	−25.9	+25.2	.301
3	.23	+16.9	−44.0	.196
4	.14	+47.3	+39.7	+0.223
Parallax star	0.23	− 4.6	+ 2.0	

TABLE 2

REDUCTIONS FOR β CANIS MAJORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
937	+0.0168	0.7	−0.847	−400	−0.0001	0″.00
1036	+ .0134	0.9	− .968	−382	+ .0034	+ .07
1037	+ .0177	1.0	− .968	−382	− .0009	− .02
1111	+ .0155	1.0	− .997	−367	+ .0013	+ .03
1876	+ .0182	1.0	+ .864	−153	− .0001	.00
1926	+ .0165	0.8	+ .838	−150	+ .0016	+ .03
1927	+ .0162	0.8	+ .838	−150	+ .0019	+ .04
2103	+ .0222	0.8	+ .407	−117	− .0042	− .08
2104	+ .0206	0.8	+ .407	−117	− .0026	− .05
2420	+ .0188	0.8	− .826	− 37	− .0009	− .02
2421	+ .0194	0.6	− .826	− 37	− .0015	− .02
2430	+ .0170	1.0	− .903	− 28	+ .0009	+ .02
2456	+ .0192	1.0	− .967	− 17	− .0013	− .03
2457	+ .0182	1.0	− .967	− 17	− .0003	− .01
4731	+ .0220	0.8	+ .748	+589	− .0016	− .03
4732	+ .0164	0.8	+ .748	+589	+ .0040	+ .07
4744	+ .0213	0.8	+ .724	+591	− .0009	− .02
4745	+0.0199	0.8	+0.724	+591	+0.0005	+0.01

The normal equations are:

$$15.4c - 1.788\mu - 2.2113\pi = + 0.2804 \text{ mm.}$$
$$+ 172.2458\mu + 23.8661\pi = + 0.0300 \text{ mm.}$$
$$+ 10.7863\pi = - 0.0294 \text{ mm.}$$

from which:

$c = + 0.01829$ mm.

$\mu = + 0.00032$ mm. $= + 0''.0066$, or $+ 0''.024$ per year.

$\pi = + 0.00032$ mm. $= + \mathbf{0''.007 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

47 AURIGÆ ($6^h\ 22^m$; $+46°\ 45'$)

This star is of type K3, of magnitude 6.0, and of small total proper motion $0''.007$. Adams and Kohlschütter have found the

radial velocity of − 41 km. per second. The spectroscopic parallax of Mt. Wilson is + 0″.009. Miss Darkow measured the McCormick plates, and derived a relative parallax of + 0″.012 ± 0″.010 with a proper motion in right ascension + 0″.006 while the value from Boss amounts to + 0″.005.

TABLE 1

PLATES OF 47 AURIGÆ

No.	Date.	Hour Angle.	Observers.	Weight.
3236	1916 Oct. 21	−0h3	M	1.0
3406	Nov. 19	−1.3	L	1.0
3407	Nov. 19	−0.9	L	1.0
3448	Nov. 27	−0.7	A	1.0
5067	1918 Feb. 12	0.0	Ol	0.4
5127	Feb. 23	−0.9	M	0.6
5128	Feb. 23	−0.6	M	0.5
5186	Mar. 8	−0.2	Ol	1.0
5829	Oct. 21	−1.0	M	0.7
5830	Oct. 21	−0.5	M	0.9
5858	Nov. 2	−1.1	M	0.9
5859	Nov. 2	−0.7	M	1.0
6307	1919 Jan. 21	−1.0	D	0.9
6308	Jan. 21	−0.5	D	1.0
6364	Jan. 27	−0.2	D	1.0
6569	Feb. 24	−0.4	H	1.0
6596	Mar. 1	−0.5	M	1.0
6597	Mar. 1	−0.1	M	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−25.6	+47.0	+0.261
2	.10	−14.1	−35.8	.223
3	.15	+ 2.3	−33.7	.233
4	.11	+37.4	+22.5	+0.283
Parallax star	0.13	+ 1.3	+ 2.8	

TABLE 2

REDUCTIONS FOR 47 AURIGÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3236	+0.0196	1.0	+0.914	−558	−0.0034	−0″.07
3406	+ .0164	1.0	+ .606	−529	− .0004	− .01
3407	+ .0143	1.0	+ .606	−529	+ .0017	+ .04
3448	+ .0150	1.0	+ .490	−521	+ .0010	+ .02
5067	+ .0138	0.4	− .734	− 79	+ .0018	+ .02
5127	+ .0161	0.6	− .848	− 68	− .0006	− .01
5128	+ .0161	0.5	− .848	− 68	− .0006	− .01
5186	+ .0130	1.0	− .944	− 55	+ .0025	+ .05
5829	+ .0182	0.7	+ .918	+172	− .0015	− .03
5830	+ .0154	0.9	+ .918	+172	+ .0013	+ .02
5858	+ .0169	0.9	+ .816	+184	− .0003	− .01
5859	+ .0141	1.0	+ .816	+184	+ .0025	+ .05
6307	+ .0180	0.9	− .424	+264	− .0020	− .04
6308	+ .0176	1.0	− .424	+264	− .0016	− .03
6364	+ .0142	1.0	− .516	+270	+ .0017	+ .04
6569	+ .0186	1.0	− .855	+298	− .0028	− .06
6596	+ .0148	1.0	− .897	+303	+ .0010	+ .02
6597	+0.0159	0.9	−0.897	+303	−0.0002	0.00

The normal equations are:

$$15.8c - 0.283\mu - 0.4161\pi = + 0.2532 \text{ mm.}$$
$$+ 173.3319\mu - 18.5319\pi = - 0.0026 \text{ mm.}$$
$$+ 9.1887\pi = - 0.0028 \text{ mm.}$$

from which:

$c = + 0.01604$ mm.

$\mu = + 0.00007$ mm. $= + 0''.0015$, or $+ 0''.006$ per year.

$\pi = + 0.00056$ mm. $= + \mathbf{0''.012 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

ϵ GEMINORUM ($6^h\ 37^m$; $+25°\ 13'$)

This star of magnitude 3.18, of spectral type G5 and of total proper motion 0″.02 has had its parallax twice determined. Allegheny Observatory by photography secured the value + 0″.008 ± 0″.008 and Adams and Joy by the spectrograph + 0″.013. Mr. Oliver measured the McCormick plates deriving the proper motion in right ascension + 0″.014 while the corresponding value from Boss is 0″.000.

TABLE 1

PLATES OF ϵ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
2405	1916 Feb. 14	$+0^h.5$	G	0.5
3424	Nov. 21	−0.8	L	0.9
3425	Nov. 21	−0.2	L	0.8
3448	Nov. 27	−0.4	A	0.9
3449	Nov. 27	0.0	A	0.9
3753	1917 Mar. 12	−0.1	L	1.1*
3758	Mar. 15	−0.2	M, A	0.6
3765	Mar. 17	−0.3	M, L	0.7
4767	Nov. 16	−1.0	B	0.9
4778	Nov. 17	−0.9	Ds	0.9
4779	Nov. 17	−0.5	Ds	0.9
5049	1918 Feb. 10	−0.3	M	0.8
5081	Feb. 13	−0.4	M	0.7
5147	Mar. 1	−0.3	Ol	1.0*

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−52.6	−12.1	+0.2880
2	.13	− 3.5	−15.6	.2212
3	.14	+11.5	−28.7	.1915
4	.16	+37.6	+56.4	+0.2993
Parallax star	0.15	− 0.9	+ 4.4	

TABLE 2

REDUCTIONS FOR ϵ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2405	+0.0028	0.5	−0.711	−461	−0.0017	−0″.02
3424	+ .0018	0.9	+ .623	−180	− .0002	.00
3425	+ .0009	0.8	+ .623	−180	+ .0007	+ .01
3448	+ .0020	0.9	+ .538	−172	− .0004	− .01
3449	.0000	0.9	+ .538	−172	+ .0016	+ .03
3753	+ .0031	1.1	− .948	− 69	− .0013	− .03
3758	− .0020	0.6	− .963	− 66	+ .0038	+ .06
3765	+ .0026	0.7	− .971	− 64	− .0008	− .01
4767	+ .0030	0.9	+ .692	+180	− .0007	− .01
4778	+ .0021	0.9	+ .679	+181	+ .0002	.00
4779	+ .0033	0.9	+ .679	+181	− .0010	− .02
5049	+ .0029	0.8	− .667	+266	− .0005	− .01
5081	− .0016	0.7	− .705	+269	+ .0040	+ .07
5147	+0.0042	1.0	−0.871	+285	−0.0018	−0.04

The normal equations are:

$$11.6c + 1.675\mu - 0.6814\pi = + 0.0225 \text{ mm.}$$
$$+ 50.1922\mu - 2.2933\pi = + 0.0123 \text{ mm.}$$
$$+ 6.3619\pi = - 0.0017 \text{ mm.}$$

from which:

$c = + 0.00192$ mm.
$\mu = + 0.00018$ mm. $= + 0''.0038$, or $+ 0''.014$ per year.
$\pi = + 0.00001$ mm. $=$ **$0''.000 \pm 0''.009$.**

Probable error of plate of unit weight

$$\pm 0.00114 \text{ mm.} = \pm 0''.024.$$

ξ GEMINORUM ($6^h\ 39^m$; $+13°\ 0'$)

This star has a total proper motion of $0''.23$, it is of 3.40 magnitude, and of type F5. Allegheny Observatory by photography finds the parallax of $+ 0''.055$, Mt. Wilson obtains the

spectroscopic value of + 0″.042. The fifteen plates of the series were measured by Mr. Olivier, who finds the proper motion in right ascension to be − 0″.118 per year, while the value from Boss is − 0″.114.

TABLE 1

PLATES OF ξ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
559	1914 Nov. 11	+0h1	A	1.0
964	1915 Mar. 1	+0.2	G	0.9
965	Mar. 1	+0.6	G	0.9
1134	Mar. 31	+0.9	G	1.0
1895	Oct. 28	−0.2	Ol	0.8
1896	Oct. 28	+0.3	Ol	1.0
1942	Nov. 1	−0.3	Ol	0.9
1943	Nov. 1	+0.2	Ol	0.8
2034	Nov. 17	+0.2	A	0.8
2035	Nov. 17	+0.6	A	0.9
2496	1916 Mar. 17	+1.0	Ol	0.7
2497	Mar. 17	+1.4	Ol	0.6
2518	Mar. 23	+1.2	Ol	0.9
2537	Mar. 31	+1.1	G	0.7
2538	Mar. 31	+1.5	G	0.8

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−60.8	+31.9	+0.2625
2	.11	−40.8	−12.4	.2208
3	.21	+50.8	+ 9.3	.2795
4	.19	+50.8	−28.8	+0.2372
Parallax star	0.20	+ 1.3	+ 1.4	

TABLE 2

REDUCTIONS FOR ξ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
559	+0.0128	1.0	+0.759	−334	−0.0003	−0″.01
964	+ .0084	0.9	− .865	−225	− .0005	− .01
965	+ .0061	0.9	− .865	−225	+ .0018	+ .03
1134	+ .0082	1.0	− .997	−195	− .0010	− .02
1895	+ .0079	0.8	+ .894	+ 17	− .0006	− .01
1896	+ .0062	1.0	+ .894	+ 17	+ .0011	+ .02
1942	+ .0090	0.9	+ .862	+ 21	− .0018	− .03
1943	+ .0051	0.8	+ .862	+ 21	+ .0021	+ .04
2034	+ .0084	0.8	+ .691	+ 37	− .0017	− .03
2035	+ .0058	0.9	+ .691	+ 37	+ .0009	+ .02
2496	+ .0026	0.7	− .970	+158	− .0008	− .01
2497	− .0006	0.6	− .970	+158	+ .0024	+ .04
2518	+ .0041	0.9	− .989	+164	− .0024	− .05
2537	− .0005	0.7	− .997	+172	+ .0020	+ .03
2538	+0.0018	0.8	−0.997	+172	−0.0003	0.00

The normal equations are:

$$12.7c - 1.938\mu - 1.1923\pi = + 0.0769 \text{ mm.}$$
$$+ 34.5339\mu - 2.0961\pi = - 0.0688 \text{ mm.}$$
$$+ 10.0249\pi = + 0.0140 \text{ mm.}$$

from which:

$c = + 0.00599$ mm.

$\mu = - 0.00155$ mm. $= - 0''.0322$, or $- 0''.118$ per year.

$\pi = + 0.00179$ mm. $= + \mathbf{0''.037 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00101 \text{ mm.} = \pm 0''.021.$$

97 MONOCEROTIS ($6^h\ 45^m$; $-0°\ 25'$)

This star, Lalande 13198, is a double star, β 897. The principal star has considerable proper motion of $0''.18$, and this is shared by the companion. The principal star is of A type, and of

magnitude 5.83. The companion is of 12th magnitude, and at a distance of nearly 6″. The rotating sector eliminated the companion. Flint by means of the meridian circle finds a parallax of + 0″.25 ± 0″.065. At Swarthmore, by photography,

TABLE 1

PLATES OF 97 MONOCEROTIS

No.	Date.	Hour Angle.	Observers.	Weight.
419	1914 Oct. 21	0h0	M	0.9
442	Oct. 30	−0.8	A	0.8
443	Oct. 30	−0.2	A	1.0
534	Nov. 9	−0.1	G	0.9
865	1915 Feb. 9	+0.3	M	1.0
866	Feb. 9	+0.8	M	0.9
923	Feb. 20	−0.6	A	0.7
1048	Mar. 13	+0.2	A	0.8
1049	Mar. 13	+0.6	A	1.0
1799	Oct. 9	−0.5	M	0.7*
1800	Oct. 9	−0.2	M	0.9
1811	Oct. 10	−0.5	A	1.0
1812	Oct. 10	−0.2	A	1.0
5203	1918 Mar. 18	+0.5	M	1.0
5204	Mar. 18	+0.8	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−30.1	−43.0	+0.1771
2	.15	−19.8	−27.7	.1737
3	.16	−18.6	+ 6.9	.1862
4	.11	− 0.1	+35.6	.1807
5	.15	+ 7.9	+50.1	.1792
6	.18	+60.7	−21.9	+0.1031
Parallax star	0.16	− 4.6	+ 2.0	

the parallax has been determined to be $+ 0''.015 \pm 0''.008$. The plates were measured by Mr. Alden, who found a proper motion in right ascension of $+ 0''.001$ while the value from Porter is $+ 0''.008$.

TABLE 2

REDUCTIONS FOR 97 MONOCEROTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
419	−0.0015	0.9	+0.946	−305	−0.0012	−0″.02
442	− .0006	0.8	+ .886	−296	− .0022	− .04
443	− .0026	1.0	+ .886	−296	− .0002	.00
534	− .0022	0.9	+ .795	−286	− .0007	− .01
865	− .0028	1.0	− .627	−194	− .0019	− .04
866	− .0028	0.9	− .627	−194	− .0019	− .04
923	− .0065	0.7	− .762	−183	+ .0017	+ .03
1048	− .0094	0.8	− .940	−162	+ .0043	+ .08
1049	− .0050	1.0	− .940	−162	− .0001	.00
1799	− .0026	0.7	+ .991	+ 48	.0000	.00
1800	− .0058	0.9	+ .991	+ 48	+ .0032	+ .06
1811	− .0034	1.0	+ .989	+ 49	+ .0008	+ .02
1812	− .0028	1.0	+ .989	+ 49	+ .0002	.00
5203	− .0034	1.0	− .967	+939	− .0016	− .03
5204	−0.0053	1.0	−0.967	+939	+0.0003	+0.01

The normal equations are:

$$13.6c + 1.998\mu + 1.3746\pi = - 0.0507 \text{ mm.}$$
$$+ 222.9168\mu - 19.7654\pi = - 0.0303 \text{ mm.}$$
$$+ 10.9289\pi = + 0.0083 \text{ mm.}$$

from which:

$c = - 0.00386$ mm.

$\mu = + 0.00001$ mm. $= + 0''.0002$, or $+ 0''.001$ per year.

$\pi = + 0.00126$ mm. $= + \mathbf{0''.026 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

LALANDE 13427 (6^h 54^m; $+48°$ $32'$)

This star of magnitude 8.2, of type K1 has a total proper motion 0″.71 per year. Its parallax has been twice determined trigonometrically: Chase with the Yale heliometer deriving the value + 0″.011 ± 0″.029, and Schlesinger by photography with the 40-inch Yerkes refractor the result + 0″.049 ± 0″.011. The spectroscopic parallax is + 0″.048. Miss Hawes measured the McCormick plates and found a relative parallax + 0″.007 ± 0.007. The proper motion in right ascension determined by her was + 0″.556 per year while the corresponding value from Porter amounted to + 0″.548.

TABLE 1

PLATES OF LALANDE 13427

No.	Date.	Hour Angle.	Observers.	Weight.
3203	1916 Oct. 14	−0^h.3	M	1.0
3204	Oct. 14	0.0	M	1.0
3376	Nov. 10	−0.9	A	1.0
3392	Nov. 16	−0.3	M	1.0
5129	1918 Feb. 23	−0.5	M	0.8
5130	Feb. 23	−0.2	M	1.0
5153	Mar. 2	−0.8	M	1.0
5154	Mar. 2	−0.4	M	1.0
5831	Oct. 28	−0.7	M	1.0
5832	Oct. 28	−0.3	M	1.0
5860	Nov. 2	−0.8	M	1.0
5861	Nov. 2	−0.4	M	1.0
6336	1919 Jan. 24	−1.0	D	1.0
6337	Jan. 24	−0.5	D	1.0
6602	Mar. 3	−0.3	D	1.0
6603	Mar. 3	+0.1	D	1.0
6689	Mar. 18	−0.2	Ol	1.0
7977	Oct. 27	−0.7	F	1.0
8045	Nov. 13	−0.8	F	1.0
8046	Nov. 13	−0.4	F	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0:12	−32.2	+28.4	+0.246
2	.08	−34.9	−42.1	.290
3	.12	+11.8	+ 8.5	.240
4	.10	+55.3	+ 5.2	+0.224
Parallax star	0.12	− 2.0	− 2.8	

TABLE 2

REDUCTIONS FOR LALANDE 13427

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3203	+0.0210	1.0	+0.980	−635	−0.0007	−0″.01
3204	+ .0205	1.0	+ .980	−635	− .0002	.00
3376	+ .0224	1.0	+ .802	−608	− .0002	.00
3392	+ .0196	1.0	+ .732	−602	+ .0030	+ .06
5129	+ .0575	0.8	− .775	−138	− .0014	− .03
5130	+ .0558	1.0	− .775	−138	+ .0003	+ .01
5153	+ .0562	1.0	− .845	−131	+ .0004	+ .01
5154	+ .0582	1.0	− .845	−131	− .0016	− .03
5831	+ .0793	1.0	+ .914	+109	− .0046	− .10
5832	+ .0770	1.0	+ .914	+109	− .0023	− .05
5860	+ .0719	1.0	+ .877	+114	+ .0032	+ .07
5861	+ .0740	1.0	+ .877	+114	+ .0011	+ .02
6336	+ .0802	1.0	− .356	+197	+ .0005	+ .01
6337	+ .0820	1.0	− .356	+197	− .0013	− .03
6602	+ .0810	1.0	− .852	+235	+ .0023	+ .05
6603	+ .0829	1.0	− .852	+235	+ .0004	+ .01
6689	+ .0850	1.0	− .955	+250	− .0006	− .01
7977	+ .1012	1.0	+ .922	+473	+ .0002	.00
8045	+ .1014	1.0	+ .775	+490	+ .0012	+ .02
8046	+0.1025	1.0	+0.775	+490	+0.0001	0.00

The normal equations are:

$$19.8c + 0.226\mu + 3.0920\pi = + 1.3181 \text{ mm.}$$
$$+ 261.1370\mu - 9.4362\pi = + 1.9236 \text{ mm.}$$
$$+ 13.4867\pi = + 0.1410 \text{ mm.}$$

from which:

$c = + 0.06643$ mm.
$\mu = + 0.00732$ mm. $= + 0''.1523$, or $+ 0''.556$ per year.
$\pi = + 0.00035$ mm. $= + \mathbf{0''.007} \pm \mathbf{0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

BOSS 1846 ($7^h\ 5^m$; $+51°\ 35'$)

This star is of small proper motion $0''.019$, of magnitude 5.69, and of type Ma. It has a radial velocity $-$ 49 km. per second. The spectroscopic parallax is $+ 0''.011$. Miss Hawes measured the plates and found a relative parallax $- 0''.011 \pm 0''.012$, with a proper motion in right ascension $+ 0''.019$ while the corresponding value from Boss is $+ 0''.018$.

TABLE 1

PLATES OF BOSS 1846

No.	Date.	Hour Angle.	Observers.	Weight.
3276	1916 Oct. 25	$-0^h.5$	L	1.0
3277	Oct. 25	−0.2	L	0.9
3314	Oct. 31	−1.2	L	1.0
3315	Oct. 31	−0.8	L	1.0
5187	1918 Mar. 8	−0.4	Ol	0.8
5188	Mar. 8	0.0	Ol	1.0
5190	Mar. 11	−0.4	A	0.8
5191	Mar. 11	0.0	A	0.8
5925	Nov. 10	−0.6	M	0.8
5937	Nov. 11	−0.7	F	0.9
5938	Nov. 11	−0.2	C	0.5
6033	Nov. 30	−0.7	M	1.0
6365	1919 Jan. 27	−0.2	D	1.0
6403	Jan. 30	−0.8	H	1.0
6404	Jan. 30	−0.3	H	1.0
6598	Mar. 1	−0.3	M	1.0
6599	Mar. 1	0.0	M	1.0
6709	Mar. 21	−0.3	D	1.0
6720	Mar. 22	−0.1	H	1.0
6729	Mar. 23	0.0	M	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−46.6	+34.7	+0.147
2	.14	−35.9	−15.6	.255
3	.08	+18.8	−22.3	.240
4	.13	+28.9	−33.4	.260
5	.13	+34.8	+36.6	+0.098
Parallax star	0.13	− 0.6	− 9.4	

TABLE 2

REDUCTIONS FOR BOSS 1846

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3276	+0.0268	1.0	+0.943	−592	−0.0018	−0″.04
3277	+ .0230	0.9	+ .943	−592	+ .0020	+ .04
3314	+ .0252	1.0	+ .906	−586	− .0001	.00
3315	+ .0266	1.0	+ .906	−586	− .0015	− .03
5187	+ .0275	0.8	− .872	− 93	− .0002	.00
5188	+ .0269	1.0	− .872	− 93	+ .0004	+ .01
5190	+ .0277	0.8	− .896	− 90	− .0004	− .01
5191	+ .0231	0.8	− .896	− 90	+ .0042	+ .08
5925	+ .0236	0.8	+ .828	+154	+ .0034	+ .06
5937	+ .0277	0.9	+ .818	+155	− .0007	− .01
5938	+ .0230	0.5	+ .818	+155	+ .0040	+ .06
6033	+ .0298	1.0	+ .592	+174	− .0027	− .06
6365	+ .0267	1.0	− .362	+232	+ .0011	+ .02
6403	+ .0307	1.0	− .410	+235	− .0029	− .06
6404	+ .0250	1.0	− .410	+235	+ .0028	+ .06
6598	+ .0313	1.0	− .806	+265	− .0032	− .07
6599	+ .0316	1.0	− .806	+265	− .0035	− .07
6709	+ .0249	1.0	− .955	+285	+ .0033	+ .07
6720	+ .0294	1.0	− .960	+286	− .0012	− .02
6729	+0.0278	1.0	−0.964	+287	+0.0004	+0.01

The normal equations are:

$$18.5c - 0.040\mu - 2.6729\pi = + 0.5014 \text{ mm.}$$
$$+ 201.4200\mu - 29.9226\pi = + 0.0650 \text{ mm.}$$
$$+ 12.3496\pi = - 0.0863 \text{ mm.}$$

from which:

$c = + 0.02702$ mm.

$\mu = + 0.00025$ mm. $= + 0''.0052$, or $+ 0''.019$ per year.

$\pi = - 0.00053$ mm. $= - \mathbf{0''.011 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00164 \text{ mm.} = \pm 0''.034.$$

LALANDE 14146 ($7^h\ 11^m$; $-12°\ 53'$)

This star of 7.3 magnitude, of G type, and of total proper motion 0″.55 has had its parallax twice determined. Chase with the Yale heliometer derives the relative parallax of + 0″.072 ± 0″.020, and Adams with the spectrograph the absolute parallax of + 0″.023. Mr. Alden measured the McCormick plates, and found the relative parallax of + 0″.031 ± 0″.010. The proper motion in right ascension from the plates is − 0″.488 per year, while the value from Porter is − 0″.501.

TABLE 1

PLATES OF LALANDE 14146

No.	Date.	Hour Angle.	Observers.	Weight.
3266	1916 Oct. 24	−0^{h}7	M	1.0
3267	Oct. 24	−0.3	M	1.0
3350	Nov. 5	−0.9	L	0.7*
3362	Nov. 7	−0.1	L	0.9
3673	1917 Feb. 16	+0.2	Ol	1.0
3674	Feb. 16	+0.5	Ol	0.7
3716	Mar. 6	−0.5	M	0.9
3737	Mar. 9	+0.3	Ol	1.0
3738	Mar. 9	+0.8	Ol	1.0
4607	Oct. 20	−0.5	M	0.8
4746	Nov. 9	−0.3	B	1.0
4747	Nov. 9	+0.1	B	1.0
4780	Nov. 17	−0.5	Ds	0.8
4781	Nov. 17	−0.2	Ds	0.8
5100	1918 Feb. 17	+0.7	M	1.0
5216	Mar. 25	+0.6	A	0.8
5230	Mar. 27	+0.6	M	1.0
5231	Mar. 27	+1.0	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−42.5	+36.1	+0.2040
2	.10	−28.5	−18.1	.1767
3	.11	− 5.3	−22.1	.1841
4	.11	+13.6	−15.9	.1960
5	.10	+62.7	+20.0	+0.2392
Parallax star	0.12	+ 3.0	+ 1.8	

TABLE 2

REDUCTIONS FOR LALANDE 14146

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3266	+0.0045	1.0	+0.953	−269	+0.0007	+0″.01
3267	+ .0068	1.0	+ .953	−269	− .0016	− .03
3350	+ .0080	0.7	+ .876	−257	− .0036	− .06
3362	+ .0012	0.9	+ .860	−255	+ .0030	+ .06
3673	− .0050	1.0	− .647	−154	+ .0005	+ .01
3674	+ .0010	0.7	− .647	−154	− .0055	− .10
3716	− .0072	0.9	− .847	−136	+ .0012	+ .02
3737	− .0069	1.0	− .873	−133	+ .0007	+ .01
3738	− .0086	1.0	− .873	−133	+ .0024	+ .05
4607	− .0191	0.8	+ .970	+ 92	+ .0012	+ .02
4746	− .0180	1.0	+ .844	+112	− .0014	− .03
4747	− .0197	1.0	+ .844	+112	+ .0003	+ .01
4780	− .0254	0.8	+ .764	+120	+ .0054	+ .10
4781	− .0166	0.8	+ .764	+120	− .0034	− .06
5100	− .0264	1.0	− .657	+212	− .0017	− .04
5216	− .0302	0.8	− .968	+248	− .0006	− .01
5230	− .0318	1.0	− .975	+250	+ .0008	+ .02
5231	−0.0308	1.0	−0.975	+250	−0.0002	0.00

The normal equations are:

$$16.4c - 1.976\mu - 0.0100\pi = - 0.2080 \text{ mm.}$$
$$+ 61.5867\mu - 7.7410\pi = - 0.3805 \text{ mm.}$$
$$+ 12.0946\pi = + 0.0679 \text{ mm.}$$

from which:

$c = - 0.01346$ mm.

$\mu = - 0.00642$ mm. $= - 0''.1336$, or $- 0''.488$ per year.

$\pi = + 0.00149$ mm. $= + \mathbf{0''.031 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00164 \text{ mm.} = \pm 0''.034.$$

δ GEMINORUM ($7^h\ 14^m$; $+22°\ 9'$)

This star of magnitude 3.51 and of type F has a companion of 8.2 magnitude at a distance of 7″ which is in very slow motion about the principal star, the two stars having a common proper motion of 0″.035 per year. The parallax of Allegheny by photography is + 0″.055. Adams and Joy find the spectroscophic parallax + 0″.026. The McCormick result is + 0″.060 ± 0″.006, with a proper motion in right ascension of − ″.0041 while Boss gives the value − 0″.016. Mr. Olivier measured the series of plates.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Depcndence.
	mm.	mm.	mm.	
1	0.31	+33.2	−12.3	+0.2888
2	.19	+ 8.2	−36.0	.3133
3	.11	+ 5.0	+33.2	.1987
4	.16	−46.4	+15.1	+0.1992
Parallax star	0.26	+ 3.9	− 5.2	

TABLE 1

PLATES OF δ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
485	1914 Nov. 3	-1^h1	G	0.8
486	Nov. 3	−0.6	G	0.9
535	Nov. 9	0.0	G	0.9
536	Nov. 9	+0.5	G	0.9
890	1915 Feb. 17	+0.7	G	0.9
953	Feb. 26	+0.8	G	0.6*
1088	Mar. 19	+0.5	G	1.0
1145	Apr. 4	−0.7	M	0.6*
1849	Oct. 24	−0.6	G	0.6*
1912	Oct. 29	−1.1	G	0.6*
1913	Oct. 29	−0.6	G	0.6*
1960	Nov. 3	−0.4	G	0.7*
2005	Nov. 10	−0.3	G	0.6*
2448	1916 Mar. 8	−0.2	G	1.0
2449	Mar. 8	+0.3	G	0.8
2478	Mar. 15	+0.4	G	0.9
2479	Mar. 15	+0.9	G	0.7
3219	Oct. 19	−0.8	L	0.7*
3247	Oct. 22	−0.8	L	0.8
3248	Oct. 22	−0.4	L	0.5
3325	Nov. 1	−0.8	A	0.9
3326	Nov. 1	−0.4	A	1.0
3768	1917 Mar. 19	+0.3	Ol	0.9
3769	Mar. 19	+0.8	Ol	0.8
3832	Mar. 31	+0.5	Ol	0.8
3833	Mar. 31	+0.9	A	0.9
3848	Apr. 7	+1.5	A	0.9
4590	Oct. 15	−0.6	B	0.8
4769	Nov. 16	−0.5	B	0.9
4770	Nov. 16	−0.2	B	0.9
4829	Dec. 1	−0.3	B	0.9
4830	Dec. 1	+0.1	B	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR δ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
485	−0.0046	0.8	+0.900	−558	−0.0008	−0″.01
486	− .0047	0.9	+ .900	−558	− .0007	− .01
535	− .0098	0.9	+ .852	−552	+ .0042	+ .08
536	− .0030	0.9	+ .852	−552	− .0026	− .05
890	− .0127	0.9	− .643	−452	+ .0022	+ .04
953	− .0077	0.6	− .753	−443	− .0031	− .05
1088	− .0136	1.0	− .933	−422	+ .0021	+ .04
1145	− .0091	0.6	− .991	−406	− .0027	− .04
1849	− .0100	0.6	+ .959	−203	+ .0028	+ .05
1912	− .0075	0.6	+ .934	−198	+ .0002	.00
1913	− .0088	0.6	+ .934	−198	+ .0015	+ .02
1960	− .0075	0.7	+ .903	−193	+ .0001	.00
2005	− .0062	0.6	+ .846	−186	− .0014	− .02
2448	− .0114	1.0	− .860	− 67	− .0018	− .04
2449	− .0111	0.8	− .860	− 67	− .0021	− .04
2478	− .0117	0.9	− .913	− 60	− .0017	− .03
2479	− .0124	0.7	− .913	− 60	− .0010	− .02
3219	− .0096	0.7	+ .974	+158	+ .0005	+ .01
3247	− .0097	0.8	+ .964	+161	+ .0006	+ .01
3248	− .0080	0.5	+ .964	+161	− .0011	− .02
3325	− .0069	0.9	+ .910	+171	− .0024	− .05
3326	− .0112	1.0	+ .910	+171	+ .0019	+ .04
3768	− .0180	0.9	− .937	+309	+ .0026	+ .05
3769	− .0192	0.8	− .937	+309	+ .0038	+ .07
3832	− .0145	0.8	− .984	+321	− .0011	− .02
3833	− .0171	0.9	− .984	+321	+ .0015	+ .03
3848	− .0150	0.9	− .993	+328	− .0007	− .01
4590	− .0100	0.8	+ .984	+519	− .0010	− .02
4769	− .0113	0.9	+ .782	+551	− .0004	− .01
4770	− .0103	0.9	+ .782	+551	− .0014	− .03
4829	− .0132	0.9	+ .599	+566	+ .0008	+ .02
4830	−0.0120	1.0	+0.599	+566	−0.0004	−0.01

The normal equations are:

$$25.8c + 3.903\mu + 3.1701\pi = -0.2780 \text{ mm.}$$
$$+ 370.0527\mu + 1.4395\pi = -0.2384 \text{ mm.}$$
$$+ 20.1482\pi = +0.0226 \text{ mm.}$$

from which:

$c = -0.01105$ mm.
$\mu = -0.00054$ mm. $= -0''.0112$, or $-0''.041$ per year.
$\pi = +0.00290$ mm. $= +\mathbf{0''.060 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

ι GEMINORUM ($7^h\ 19^m$; $+28°\ 0'$)

The spectroscopic parallax of this star is $+0''.013$. The Allegheney value by photography is $+0''.035 \pm 0''.008$. The star is of K type, of magnitude 3.89, and of total proper motion $0''.145$.

TABLE 1

PLATES OF ι GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
572	1914 Nov. 12	0^h0	M	0.9
618	Nov. 22	−0.5	A	1.0
924	1915 Feb. 20	−0.6	A	0.7*
1001	Mar. 8	+0.1	G	0.9
1014	Mar. 9	−0.6	A	1.0
1015	Mar. 9	0.0	A	1.0
1077	Mar. 18	0.0	A, Ol	0.9
1878	Oct. 27	−0.1	A	0.9
1953	Nov. 2	−1.2	A	1.0
1954	Nov. 2	−0.9	A	1.0
2201	Dec. 22	−0.1	G	0.9
2214	Dec. 23	−0.1	A	1.0
2441	1916 Mar. 4	−0.2	A	1.0
2442	Mar. 4	+0.1	A	1.0

* One exposure.

The McCormick value of proper motion in right ascension is $-0''.085$, while that due to Boss is $-0''.082$. The series of plates was measured by Mr. Alden.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−41.3	−14.8	+0.3002
2	.16	−27.9	−32.2	.2571
3	.15	+22.4	−23.5	.2130
4	.18	+46.8	+40.9	+0.2297
Parallax star	0.22	− 4.1	+ 0.5	

TABLE 2

REDUCTIONS FOR ι GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
572	+0.0041	0.9	+0.836	−244	+0.0001	0″.00
618	+ .0030	1.0	+ .732	−234	+ .0010	+ .02
924	+ .0036	0.7	− .665	−144	− .0011	− .02
1001	+ .0010	0.9	− .841	−128	+ .0012	+ .02
1014	+ .0041	1.0	− .850	−127	− .0019	− .04
1015	+ .0016	1.0	− .850	−127	+ .0006	+ .01
1077	+ .0022	0.9	− .919	−118	− .0001	.00
1878	+ .0021	0.9	+ .949	+105	− .0018	− .03
1953	− .0008	1.0	+ .916	+111	+ .0010	+ .02
1954	+ .0018	1.0	+ .916	+111	− .0016	− .02
2201	− .0012	0.9	+ .306	+161	+ .0006	+ .01
2214	− .0019	1.0	+ .290	+162	+ .0013	+ .03
2441	− .0018	1.0	− .810	+234	.0000	.00
2442	−0.0020	1.0	−0.810	+234	+0.0002	0.00

The normal equations are:

$$13.2c + 0.616\mu - 0.6336\pi = +0.0139 \text{ mm.}$$
$$+ 37.6038\mu + 1.2781\pi = -0.0410 \text{ mm.}$$
$$+ 8.2853\pi = +0.0011 \text{ mm.}$$

from which:

$c = +0.00112$ mm.
$\mu = -0.00112$ mm. $= -0''.0233$, or $-0''.085$ per year.
$\pi = +0.00039$ mm. $= +\mathbf{0''.008 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00081 \text{ mm.} = \pm 0''.017.$$

ρ GEMINORUM ($7^h\ 22^m$; $+31°\ 59'$)

The parallax for this star by the meridian circle of Jost is $+0''.045 \pm 0''.028$. Adams and Joy give the spectroscopic parallax

TABLE 1

PLATES OF ρ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
3294	1916 Oct. 27	-1^h1	M	1.0
3336	Nov. 2	−0.9	M	1.0
3337	Nov. 2	−0.6	M	1.0
3408	Nov. 19	−1.3	L	1.0
3409	Nov. 19	−1.0	L	1.0
3750	1917 Mar. 10	−0.4	A	0.8
3759	Mar. 15	−0.4	A	0.9
3760	Mar. 15	0.0	A	0.8
4619	Oct. 21	−0.5	B	1.0
4620	Oct. 21	−0.1	B	0.9
4648	Oct. 30	−1.1	B	1.0
4649	Oct. 30	−0.8	B	1.0
4803	Nov. 22	−0.9	B	1.0
5098	1918 Feb. 17	−0.6	M	0.9
5099	Feb. 17	−0.2	M	0.9
5155	Mar. 2	−0.4	M	1.0
5156	Mar. 2	0.0	M	1.0
5833	Oct. 21	−0.3	M	1.0
5834	Oct. 21	0.0	M	1.0
5887	Nov. 5	−1.1	M	1.0
5888	Nov. 5	−0.8	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−28.8	+44.9	+0.2959
2	.12	− 7.3	−40.8	.2493
3	.12	+ 0.1	−22.5	.2446
4	.10	+36.0	+18.4	+0.2102
Parallax star	0.12	− 2.7	+ 1.5	

TABLE 2

REDUCTIONS FOR ρ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3294	+0.0024	1.0	+0.948	−342	+0.0001	0″.00
3336	+ .0024	1.0	+ .915	−336	+ .0001	.00
3337	+ .0017	1.0	+ .915	−336	+ .0008	+ .02
3408	+ .0004	1.0	+ .767	−319	+ .0021	+ .04
3409	+ .0035	1.0	+ .767	−319	− .0010	− .02
3750	+ .0006	0.8	− .856	−208	+ .0004	+ .01
3759	− .0012	0.9	− .896	−203	+ .0022	+ .04
3760	+ .0026	0.8	− .896	−203	− .0016	− .03
4619	+ .0142	1.0	+ .972	+ 17	− .0035	− .07
4620	+ .0092	0.9	+ .972	+ 17	+ .0015	+ .03
4648	+ .0136	1.0	+ .934	+ 26	− .0028	− .06
4649	+ .0096	1.0	+ .934	+ 26	+ .0012	+ .02
4803	+ .0121	1.0	+ .736	+ 49	− .0013	− .03
5098	+ .0115	0.9	− .619	+136	− .0021	− .04
5099	+ .0075	0.9	− .619	+136	+ .0019	+ .04
5155	+ .0082	1.0	− .777	+149	+ .0011	+ .02
5156	+ .0114	1.0	− .777	+149	− .0021	− .04
5833	+ .0202	1.0	+ .973	+382	− .0012	− .02
5834	+ .0180	1.0	+ .973	+382	+ .0010	+ .02
5887	+ .0160	1.0	+ .897	+397	+ .0031	+ .06
5888	+0.0190	1.0	+0.897	+397	+0.0001	0.00

+ 0″.025. The star is of magnitude 4.18, and of type F, and a total proper motion 0″.23. Eleven of the McCormick plates were measured by Mr. Mitchell, the other ten by Mr. Briggs. The relative parallax is + 0″.052 ± 0″.007, with a proper motion in right ascension + 0″.173, while the corresponding value from Boss is + 0″.149.

The normal equations are:

$$20.2c + 0.706\mu + 7.6266\pi = + 0.1796 \text{ mm.}$$
$$+ 134.0007\mu + 2.1175\pi = + 0.3157 \text{ mm.}$$
$$+ 15.1820\pi = + 0.1029 \text{ mm.}$$

from which:

$c = + 0.00786$ mm.
$\mu = + 0.00227$ mm. $= + 0''.0473$, or $+ 0''.173$ per year.
$\pi = + 0.00251$ mm. $= + \mathbf{0''.052 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

α GEMINORUM ($7^h\ 28^m$; $+32°\ 6'$)

This brilliant pair needs no detailed description. According to Burnham's General Catalogue, "the period and all other details of the orbit are wholly unknown, and the problem of finding the elements of the orbit is absolutely indeterminate at this time, and likely to remain so for another century or longer." The periods range all the way from 232 years to 1000 years. The stars are of A type, the preceding star of magnitude 2.85 and the following of magnitude 1.99. Each component is a spectroscopic binary. The angular separation is approximately 5″. On account of the brilliancy and the close proximity of the pair, it is only natural that the determinations of the parallax should be rather discordant. Those published are as follows:

Authority.	Method.	Brighter Star.	Mean.	Fainter Star.
Johnston	Heliometer		+0″.198±0″.062	
Flint, 1	Merid. Circle		− .17 ± .041	
Flint, 2	Merid. Circle		+ .174± .031	
Russell	Photography	+0″.102±0″.028	+ .103± .023	+0″.104±0″.036
Smith	Heliometer	+ .022± .010		
Yerkes	Photography	+ .063± .008	+ .059± .006	+ .053± .010
Allegheny	Photography	.054± .007	.070± .005	.085± .007

The system has a considerable proper motion 0″.204 per year. Mr. Alden measured the McCormick plates except five which were measured by Mr. Mitchell. The parallaxes of brighter and fainter stars are, + 0″.067 ± 0″.010 and + 0″.086 ± 0″.007, respectively. Taking the mean of the two results, the parallax of the system is:

+ 0″.076 ± 0″.006

According to Boss, the proper motion of the center of gravity of the system in right ascension is − 0″.172 per year. The proper motions determined from the plates are, − 0″.182 and − 0″.119 for the brighter and the fainter stars respectively. This would show that the brighter star is the more massive, but on account of the uncertainties in the proper motions of the center of gravity and of the two components, it is regarded that the present investigation can tell but little of the relative masses of the components. From all the evidence at present available, we must conclude that we know as little of the relative masses of the components as we know of the period.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−57.4	−19.9	+0.1937
2	.10	−24.7	−16.3	.2018
3	.13	− 5.6	− 8.4	.2032
4	.16	+30.8	+53.4	.1785
5	.11	+56.9	− 8.8	+0.2228
Brighter star	.17	+ 0.9	− 1.3	
Fainter star	0.14			

TABLE 1

PLATES OF α GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
1832	1915 Oct. 21	$-0^h.9$	M	0.5*
1931	Oct. 30	0.0	M	0.7
1966	Nov. 4	−0.7	M	0.8
2106	Dec. 2	−0.9	M	0.6*
2165	Dec. 18	−0.2	M	0.5*
2453	1916 Mar. 9	−0.2	A	0.9
2454	Mar. 9	0.0	A	0.7*
2512	Mar. 19	−0.3	M	0.9
2513	Mar. 19	0.0	M	0.5*
3302	Oct. 28	−1.2	M	1.0
3303	Oct. 28	−0.9	M	0.9
3716	1917 Mar. 8	−0.5	M	0.9
3717	Mar. 8	−0.4	M	0.7
3790	Mar. 22	−0.2	M, A	0.8
3791	Mar. 22	+0.1	A	0.9
3795	Mar. 24	−0.5	M	0.7
3796	Mar. 24	−0.2	M	0.7
4553	Oct. 9	−1.2	A	0.8
4554	Oct. 9	−0.9	A	0.8
4660	Oct. 31	−0.8	A	0.8
4684	Nov. 2	−0.8	M	0.6*
5215	1918 Mar. 25	−0.4	A	0.9
5219	Mar. 26	−0.2	Ol	1.0
5229	Mar. 27	−0.2	M	1.0
5235	Mar. 28	−0.2	A	0.9
5862	Nov. 2	−0.6	M	1.0
5863	Nov. 2	−0.3	M	1.0
5889	Nov. 5	−0.6	M	1.0
5890	Nov. 5	−0.2	M	1.0

* One exposure.

The normal equations are:

$$23.5c + 11.034\mu + 0.3354\pi = -1.6042 \text{ mm.}$$
$$+ 323.3680\mu + 9.2370\pi = -1.2131 \text{ mm.}$$
$$+ 19.4453\pi = +0.0432 \text{ mm.}$$

TABLE 2

REDUCTIONS OF α GERMINORUM, BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1832	−0.0530	0.5	+0.976	−533	−0.0022	−0″.03
1931	− .0570	0.7	+ .942	−524	+ .0015	+ .02
1966	− .0561	0.8	+ .914	−519	+ .0004	+ .01
2106	− .0531	0.6	+ .635	−491	− .0042	− .07
2165	− .0580	0.5	+ .402	−475	− .0005	− .01
2453	− .0662	0.9	− .830	−393	+ .0013	+ .03
2454	− .0671	0.7	− .830	−393	+ .0022	+ .04
2512	− .0654	0.9	− .915	−383	.0000	.00
2513	− .0669	0.5	− .915	−383	+ .0015	+ .02
3302	− .0578	1.0	+ .948	−160	− .0034	− .07
3303	− .0650	0.9	+ .948	−160	+ .0038	+ .07
3716	− .0728	0.9	− .825	− 29	+ .0022	+ .04
3717	− .0697	0.7	− .825	− 29	− .0008	− .01
3790	− .0720	0.8	− .932	− 15	+ .0008	+ .01
3791	− .0718	0.9	− .932	− 15	+ .0006	+ .01
3795	− .0744	0.7	− .943	− 13	+ .0031	+ .05
3796	− .0688	0.7	− .943	− 13	− .0025	− .04
4553	− .0610	0.8	+ .984	+186	− .0054	− .10
4554	− .0695	0.8	+ .984	+186	+ .0031	+ .06
4660	− .0647	0.8	+ .934	+208	− .0023	− .04
4684	− .0675	0.6	+ .923	+210	+ .0004	+ .01
5215	− .0786	0.9	− .947	+353	+ .0016	+ .03
5219	− .0763	1.0	− .952	+354	− .0008	− .02
5229	− .0746	1.0	− .957	+355	− .0025	− .05
5235	− .0726	0.9	− .961	+356	− .0045	− .09
5862	− .0735	1.0	+ .924	+575	+ .0007	+ .01
5863	− .0752	1.0	+ .924	+575	+ .0024	+ .05
5889	− .0739	1.0	+ .905	+578	+ .0010	+ .02
5890	−0.0739	1.0	+0.905	+578	+0.0010	+0.02

from which:

$c = -0.06759$ mm.

$\mu = -0.00156$ mm. $= -0''.0325$, or $-0''.119$ per year.

$\pi = +0.00413$ mm. $= +0''.086 \pm 0''.007$.

Probable error of plate of unit weight

16 ± 0.00153 mm. $= \pm 0''.032$.

TABLE 3

REDUCTIONS FOR α GEMINORUM, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1832	+0.0990	0.5	+0.976	−533	+0.0036	+0″.05
1931	+ .1031	0.7	+ .942	−524	− .0008	− .01
1966	+ .1027	0.8	+ .914	−519	− .0006	− .01
2106	+ .1037	0.6	+ .635	−491	− .0032	− .05
2165	+ .1017	0.5	+ .402	−475	− .0023	− .04
2453	+ .0973	0.9	− .830	−393	− .0039	− .08
2454	+ .0945	0.7	− .830	−393	− .0011	− .02
2512	+ .0882	0.9	− .915	−383	+ .0047	+ .09
2513	+ .0915	0.5	− .915	−383	+ .0014	+ .02
3302	+ .0928	1.0	+ .948	−160	+ .0008	+ .02
3303	+ .0896	0.9	+ .948	−160	+ .0040	+ .08
3716	+ .0835	0.9	− .825	− 29	+ .0012	+ .02
3717	+ .0818	0.7	− .825	− 29	+ .0029	+ .05
3790	+ .0824	0.8	− .932	− 15	+ .0016	+ .03
3791	+ .0848	0.9	− .932	− 15	− .0008	− .01
3795	+ .0816	0.7	− .943	− 13	+ .0023	+ .04
3796	+ .0824	0.7	− .943	− 13	+ .0015	+ .03
4553	+ .0907	0.8	+ .984	+186	− .0053	− .10
4554	+ .0830	0.8	+ .984	+186	+ .0024	+ .04
4660	+ .0932	0.8	+ .934	+208	− .0085	− .16
4684	+ .0862	0.6	+ .923	+210	− .0016	− .02
5215	+ .0786	0.9	− .947	+353	− .0034	− .07
5219	+ .0735	1.0	− .952	+354	+ .0016	+ .03
5229	+ .0793	1.0	− .957	+355	− .0042	− .09
5235	+ .0760	0.9	− .961	+356	− .0010	− .02
5862	+ .0770	1.0	+ .924	+575	− .0012	− .02
5863	+ .0736	1.0	+ .924	+575	+ .0022	+ .05
5889	+ .0714	1.0	+ .905	+578	+ .0043	+ .09
5890	+0.0736	1.0	+0.905	+578	+0.0021	+0.04

The normal equations are:

$$23.5c + 11.034\mu + 0.3354\pi = + 2.0114 \text{ mm.}$$
$$+ 323.3680\mu + 9.2370\pi = + 0.2101 \text{ mm.}$$
$$+ 19.4453\pi = + 0.0695 \text{ mm.}$$

from which:

$c = +0.08667$ mm.

$\mu = -0.00240$ mm. $= -0''.0499$, or $-0''.182$ per year.

$\pi = +0.00322$ mm. $= +\mathbf{0''.067 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00200 \text{ mm.} = \pm 0''.042.$$

α CANIS MINORIS ($7^h\ 34^m$; $+5°\ 29'$)

There are few more interesting stars in the sky than Procyon. Its large parallax makes it one of the ten nearest stars. Its companion, discovered by Schaeberle in 1896, greatly enhances the interest. It has a large annual proper motion of $1''.23$, and it is of type F5. Its great brilliancy, 0.48 magnitude, rendered it a difficult object on which to obtain satisfactory photographs,

TABLE 1

PLATES OF PROCYON

No.	Date.	Hour Angle.	Observers.	Weight.
1050	1915 Mar. 13	$+0^h.2$	A	0.7
1059	Mar. 16	+0.2	M	0.7
1069	Mar. 17	+0.2	A	1.0
1123	Mar. 28	+0.8	M	1.0
1932	Oct. 30	+0.4	M	1.0
1933	Oct. 30	+0.7	M	1.0
1981	Nov. 7	−0.6	A	0.8
1982	Nov. 7	−0.3	A	0.9
1995	Nov. 9	−1.0	A	0.9
1996	Nov. 9	−0.8	A	0.9
2083	Nov. 27	+0.1	M	0.7
2084	Nov. 27	+0.4	M	0.7*
2460	1916 Mar. 11	+0.6	A	1.0
2461	Mar. 11	+1.0	A	0.7
2523	Mar. 25	+0.2	A	1.0
2524	Mar. 25	+0.7	A	0.8

* One exposure.

and it was necessary to have the guiding at the telescope as nearly perfect as possible. The series of plates were measured by Mr. Mitchell. The McCormick results, given below, have already been published in *Popular Astronomy*, **25**, 38, 1917.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−53.6	+19.1	+0.203
2	.19	−40.0	−31.6	.214
3	.14	+16.7	+54.4	.183
4	.21	+16.8	+ 2.8	.197
5	.23	+60.1	−44.7	+0.203
Parallax star	0.28	− 0.9	− 1.5	

TABLE 2

REDUCTIONS FOR PROCYON

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1050	−0.0263	0.7	−0.853	−230	+0.0019	+0″.03
1059	− .0222	0.7	− .862	−229	− .0024	− .04
1069	− .0249	1.0	− .886	−226	− .0003	− .01
1123	− .0278	1.0	− .953	−215	+ .0006	+ .01
1932	− .0213	1.0	+ .947	+ 1	+ .0027	+ .05
1933	− .0200	1.0	+ .947	+ 1	+ .0014	+ .03
1981	− .0182	0.8	+ .901	+ 9	− .0018	− .03
1982	− .0202	0.9	+ .901	+ 9	+ .0002	.00
1995	− .0208	0.9	+ .887	+ 11	+ .0004	+ .01
1996	− .0206	0.9	+ .887	+ 11	+ .0002	.00
2083	− .0225	0.7	+ .712	+ 29	− .0021	− .04
2084	− .0213	0.7	+ .712	+ 29	− .0033	− .06
2460	− .0574	1.0	− .843	+134	+ .0002	.00
2461	− .0551	0.7	− .843	+134	− .0021	− .04
2523	− .0599	1.0	− .942	+148	− .0001	.00
2524	− .0624	0.8	−0.942	+148	+0.0025	+0.04

The normal equations are:

$$13.8c - 1.904\mu - 0.1491\pi = -0.4344 \text{ mm.}$$
$$+ 24.2527\mu + 2.9981\pi = -0.1135 \text{ mm.}$$
$$+ 10.8276\pi = +0.1385 \text{ mm.}$$

from which:

$c = -0.03257$ mm.
$\mu = -0.00907$ mm. $= -0''.189$, or $-0''.690$ per year.
$\pi = +0.01486$ mm. $= +\mathbf{0''.309 \pm 0''.007}$.

Probable error corresponding to unit weight

$$= \pm 0.00116 \text{ mm.} = \pm 0''.024.$$

There is a surprisingly good agreement between the values of the parallax already published:

Parallax.	Authority.	Method.
$+0''.299 \pm 0''.038$	Wagner	Meridian Circle
$.34 \pm .039$	Flint	Meridian Circle
$.334 \pm .015$	Elkin	Heliometer
$+0.287 \pm .012$	Miller	Photography

Weighting these results according to their probable errors, the parallax of α Canis Minoris (including the McCormick results), comes out to be:

$$+ \mathbf{0''.309}.$$

Adams finds the spectroscopic value of $+ 0''.331$.

During the time that the above photographs were being taken, the motion of the companion was mainly in declination. Consequently, the proper motion of Procyon itself as determined by these photographs should have the same value as the proper motion of the center of gravity of the system. The annual proper motion in right ascension from the photographs is $- 0''.690$ while the corresponding value from Boss is $- 0''.666$. If we assume a period of 39.0 years, and $a = 4''.05$, the mass of Procyon is 1.41 times that of the sun.

γ MONOCEROTIS ($7^h\ 37^m$; $-9°\ 19'$)

The only parallax of this star is the spectroscopic value $+0''.013$. The star is of K type, of 4.07 magnitude, and of an annual proper

TABLE 1

PLATES OF γ MONOCEROTIS

No.	Date.	Hour Angle.	Observers.	Weight.
560	1914 Nov. 11	0h0	A	1.0
586	Nov. 17	−0.4	Ol	0.6*
619	Nov. 22	−0.2	A	1.0
666	Dec. 14	−0.2	M	0.8
699	Dec. 22	+0.1	Ol	1.0
714	Dec. 26	+0.1	Ol	0.7
925	1915 Feb. 20	−0.2	A	0.8
926	Feb. 20	+0.1	A	1.0
939	Feb. 22	+0.8	M	0.8
977	Mar. 2	+0.5	M	0.7
1112	Mar. 27	+0.3	A	0.9
1879	Oct. 27	+0.1	A	1.0
1880	Oct. 27	+0.3	A	0.5*
1955	Nov. 2	−0.6	A	0.7
1961	Nov. 3	−0.1	G	0.5*
1962	Nov. 3	+0.2	G	0.5*
2098	Nov. 30	−0.7	A	0.8
2215	Dec. 23	+0.2	A	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−26.3	+34.0	+0.2460
2	.16	−23.3	−18.6	.1612
3	.26	−19.3	+ 4.6	.2005
4	.11	+ 8.1	−24.4	.1630
5	.21	+60.8	+ 4.4	+0.2293
Parallax star	0.22	+ 1.2	+ 3.3	

motion 0″.08. The McCormick value of the proper motion in right ascension, − 0″.076 is in exact agreement with that given by Boss. Mr. Alden measured the series of plates.

TABLE 2

REDUCTIONS FOR γ MONOCEROTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
560	−0.0100	1.0	+0.873	−180	−0.0012	−0″.02
586	− .0159	0.6	+ .821	−174	+ .0046	+ .07
619	− .0103	1.0	+ .738	−169	− .0010	− .02
666	− .0122	0.8	+ .487	−147	+ .0006	+ .01
699	− .0122	1.0	+ .363	−139	+ .0006	+ .01
714	− .0102	0.7	+ .298	−135	− .0015	− .02
925	− .0136	0.8	− .612	− 79	+ .0014	+ .03
926	− .0132	1.0	− .612	− 79	+ .0010	+ .02
939	− .0090	0.8	− .639	− 77	− .0032	− .06
977	− .0148	0.7	− .737	− 69	+ .0025	+ .04
1112	− .0106	0.9	− .941	− 44	− .0020	− .04
1879	− .0152	1.0	+ .961	+170	+ .0004	+ .01
1880	− .0135	0.5	+ .961	+170	− .0013	− .02
1955	− .0143	0.7	+ .934	+176	− .0005	− .01
1961	− .0120	0.5	+ .928	+177	− .0028	− .04
1962	− .0114	0.5	+ .928	+177	− .0034	− .05
2098	− .0183	0.8	+ .683	+204	+ .0032	+ .06
2215	−0.0165	0.9	+0.350	+227	+0.0012	+0.02

The normal equations are:

$$14.2c - 1.735\mu + 3.9739\pi = -0.1833 \text{ mm.}$$
$$+ 32.5576\mu + 4.0314\pi = -0.0104 \text{ mm.}$$
$$+ 7.6134\pi = -0.0560 \text{ mm.}$$

from which:

$c = -0.01302$ mm.

$\mu = -0.00101$ mm. $= -0''.0210$, or $-0''.076$ per year.

$\pi = -0.00002$ mm. $= \mathbf{0''.000 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00131 \text{ mm.} = \pm 0''.027.$$

κ GEMINORUM ($7^h\ 38^m$; $+24°\ 38'$)

The Allegheny Observatory, by photography, derives the parallax of $+\ 0''.025 \pm 0''.007$, and Adams and Joy the spectroscopic parallax $+\ 0''.022$. This is a double, OΣ 179, the principal star being of G5 type, and of magnitude 3.68, while the com-

TABLE 1

PLATES OF κ GEMINORUM

No.	Date.	Hour Angle.	Observers.	Weight.
420	1914 Oct. 21	$-0^h.2$	M	0.8
430	Oct. 27	−0.5	Ol	0.4*
431	Oct. 27	−0.1	Ol	0.5
445	Oct. 30	0.0	A	0.8
679	Dec. 16	−0.7	G	1.0
889	1915 Feb. 17	−0.4	G	0.9
911	Feb. 19	−0.8	G	0.5*
912	Feb. 19	−0.3	G	0.8
951	Feb. 26	−0.6	G	0.5
952	Feb. 26	−0.2	G	0.5
1087	Mar. 19	−0.5	G	1.0
1850	Oct. 24	−0.6	G	0.5
1851	Oct. 24	−0.2	G	0.5
1914	Oct. 29	−0.5	G	0.6
1915	Oct. 29	−0.1	G	0.8
3393	1916 Nov. 16	−0.4	M	0.9
3394	Nov. 16	0.0	M	0.9
3426	Nov. 21	−0.6	L	1.0
3427	Nov. 21	−0.2	L	0.9
3487	Dec. 6	−1.1	A	1.0
3488	Dec. 6	−0.8	A	1.0
3731	1917 Mar. 8	−0.6	L	1.0
3732	Mar. 8	−0.4	L	0.9
3754	Mar. 12	−0.5	L	0.6
3755	Mar. 12	−0.2	L	0.6
3779	Mar. 20	−0.4	M	0.9
3839	Apr. 3	+0.1	M	0.9

* One exposure.

panion of tenth magnitude is at a distance of 6″.5. The rotating sector eliminated the companion. The series of plates were measured by Mr. Lamb, who finds a proper motion in right ascension of − 0″.019 while the value from Boss is − 0″.022.

TABLE 2

REDUCTIONS FOR κ GEMINORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
420	−0.0008	0.8	+0.977	−453	+0.0024	+0″.04
430	+ .0052	0.4	+ .961	−447	− .0037	− .05
431	+ .0060	0.5	+ .961	−447	− .0045	− .07
445	+ .0050	0.8	+ .949	−444	− .0035	− .06
679	− .0008	1.0	+ .464	−397	+ .0019	+ .04
889	+ .0011	0.9	− .563	−334	− .0009	− .02
911	+ .0041	0.5	− .591	−332	− .0039	− .06
912	+ .0014	0.8	− .591	−332	− .0012	− .02
951	− .0040	0.5	− .682	−325	+ .0041	+ .06
952	− .0022	0.5	− .682	−325	+ .0023	+ .03
1087	− .0018	1.0	− .892	−304	+ .0017	+ .04
1850	− .0042	0.5	+ .971	− 85	+ .0048	+ .07
1851	+ .0015	0.5	+ .971	− 85	− .0009	− .01
1914	+ .0026	0.6	+ .954	− 80	− .0020	− .03
1915	− .0022	0.8	+ .954	− 80	+ .0028	+ .05
3393	+ .0001	0.9	+ .830	+304	− .0005	− .01
3394	− .0016	0.9	+ .830	+304	+ .0012	+ .02
3426	− .0021	1.0	+ .781	+309	+ .0016	+ .03
3427	+ .0005	0.9	+ .781	+309	− .0010	− .02
3487	− .0012	1.0	+ .600	+324	+ .0006	+ .01
3488	+ .0010	1.0	+ .600	+324	− .0016	− .03
3731	− .0011	1.0	− .800	+416	− .0007	− .01
3732	− .0019	0.9	− .800	+416	+ .0001	+ .00
3754	− .0041	0.6	− .839	+420	+ .0022	+ .04
3755	− .0031	0.6	− .839	+420	+ .0012	+ .02
3779	− .0013	0.9	− .903	+428	− .0006	− .01
3839	+0.0008	0.9	−0.973	+442	−0.0028	−0.06

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−41.4	−28.6	+0.2320
2	.15	−23.1	+10.9	.2158
3	.10	−17.3	+19.8	.2110
4	.14	+ 4.7	+36.6	.1938
5	.13	+77.1	−38.7	+0.1474
Parallax star	0.15	− 5.96	+ 1.28	

The normal equations are:

$$20.7c + 7.846\mu + 2.2900\pi = -0.0054 \text{ mm.}$$
$$+ 255.6125\mu - 10.2279\pi = -0.0729 \text{ mm.}$$
$$+ 13.5133\pi = +0.0112 \text{ mm.}$$

from which:

$c = -0.00024$ mm.

$\mu = -0.00025$ mm. $= -0''.0052$, or $-0''.019$ per year.

$\pi = +0.00068$ mm. $= +\mathbf{0''.014 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00136 \text{ mm.} = \pm 0''.028.$$

LALANDE 15290 ($7^h\ 47^m$; $+30°\ 55'$)

This star is of more than usual interest since it has a total proper motion $1''.97$ and a very large radial velocity amounting to − 242 km. per sec. (Adams, *Astrophysical Journal*, **49**, 149, 1919). It is of magnitude 8.2 and of G type. Its parallax has been several times determined as follows: Peter with the heliometer derived the value $+ 0''.02 \pm 0''.021$, Flint with the meridian circle $- 0''.01 \pm 0''.030$, Chase with the heliometer $+ 0''.075 \pm 0''.046$, Schlesinger by photography with the 40-inch refractor $+ 0''.072 \pm 0''.019$, and Mt. Wilson with the spectrograph the absolute value $+ 0''.035$. Ten of the eighteen plates of the series were measured by Mr. Mitchell, the balance by Miss Hawes. A relative parallax $+ 0''.033 \pm 0''.007$ resulted with a proper motion in right ascension $+ 0''.701$, where the corresponding value from Porter is $+ 0''.732$.

TABLE 1

PLATES OF LALANDE 15290

No.	Date.	Hour Angle.	Observers.	Weight.
5148	1918 Mar. 1	−0h8	Ol	1.0
5244	Mar. 29	−0.1	Ol	1.0*
5946	Nov. 12	−1.0	F	1.0
5947	Nov. 12	−0.5	F	1.0
6034	Nov. 30	−0.8	M	1.0
6035	Nov. 30	−0.4	M	1.0
6533	1919 Feb. 17	−0.9	H	1.0
6534	Feb. 17	−0.5	H	1.0
6742	Mar. 24	−0.5	F	1.0
6743	Mar. 24	−0.1	F	1.0
8012	Nov. 5	−0.8	F	1.0
8013	Nov. 5	−0.5	F	1.0
8090	Nov. 17	−1.0	Ol	1.0
8091	Nov. 17	−0.6	Ol	1.0
8648	1920 Feb. 27	−0.3	M	1.0
8649	Feb. 27	0.0	M	1.0
8693	Mar. 2	−0.6	Ol	1.0
8694	Mar. 2	−0.2	Ol	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−59.9	+12.9	+0.242
2	.11	− 0.6	−26.7	.184
3	.10	+ 6.2	+ 8.9	.202
4	.12	+21.2	+31.2	.207
5	.12	+33.1	−26.3	+0.165
Parallax star	0.11	− 3.5	+ 2.1	

TABLE 2

REDUCTIONS FOR LALANDE 15290

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
5148	−0.0234	1.0	−0.696	−443	−0.0014	−0″.03
5244	− .0224	1.0	− .941	−415	− .0002	.00
5946	+ .0032	1.0	+ .882	−187	− .0019	− .04
5947	+ .0001	1.0	+ .882	−187	+ .0012	+ .02
6034	+ .0001	1.0	+ .707	−169	+ .0026	+ .05
6035	+ .0030	1.0	+ .707	−169	− .0003	− .01
6533	+ .0109	1.0	− .533	− 90	− .0029	− .06
6534	+ .0066	1.0	− .533	− 90	+ .0014	+ .03
6742	+ .0108	1.0	− .910	− 55	− .0001	.00
6743	+ .0074	1.0	− .910	− 55	+ .0033	+ .07
8012	+ .0358	1.0	+ .928	+171	− .0014	− .03
8013	+ .0348	1.0	+ .928	+171	− .0004	− .01
8090	+ .0332	1.0	+ .844	+183	+ .0022	+ .05
8091	+ .0366	1.0	+ .844	+183	− .0012	− .02
8648	+ .0440	1.0	− .665	+285	− .0016	− .03
8649	+ .0424	1.0	− .665	+285	.0000	.00
8693	+ .0420	1.0	− .714	+289	+ .0008	+ .02
8694	+0.0430	1.0	−0.714	+289	−0.0002	0.00

The normal equations are:

$$18.0c - 0.040\mu - 0.5590\pi = + 0.3081 \text{ mm.}$$
$$+ 97.2736\mu + 1.6059\pi = + 0.8998 \text{ mm.}$$
$$+ 11.2009\pi = + 0.0229 \text{ mm.}$$

from which:

$c = + 0.01719$ mm.

$\mu = + 0.00923$ mm. $= + 0''.1920$, or $+ 0''.701$ per year.

$\pi = + 0.00158$ mm. $= + \mathbf{0''.033} \pm \mathbf{0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00119 \text{ mm.} = \pm 0''.025.$$

9 PUPPIS ($7^h\ 47^m$; $-13°\ 38'$)

This star, called also 9 Argus, is of type F8 and of magnitude 5.34. It is an interesting double β 101, with considerable proper motion, 0″.35 per year. According to Lohse (*Publ. Potsdam Obs.*, **20**, 93, 1908), it has a period of 23.34 years, and a semi-major axis of 0″.69. The plates of the series were measured by Mr. Mitchell. The plates themselves were taken in six different seasons. According to the ephemeris by Aitken (*Lick Observatory Publications*, **12**, 52, 1914), the position angles and distances of the components at the means of the times for each of the six seasons at which photographs were taken are as follows:

1915.25	98°.6	0″.41
15.84	180	.00+
16.28	263.0	.11
16.81	274.5	.30
17.22	280.3	.40
17.85	282.4	0.47

A first solution of the measures as given in Table 2 was made without making any allowance for the orbital motion. This gave the solution below, where the parallax has the value + 0″.036 ± 0″.008. The proper motion has the value + 0″.035 per year, while the value of Boss for the center of gravity is − 0″.060. The difference in the values of the proper motion is due mainly to orbital motion. Any proper motion of the comparison stars, or any apparent motion of the comparison stars caused by the solar drift through space will also make a difference in the two proper motions. The motion of the comparison stars caused by the motion of the sun will amount to approximately − 0″.007 in right ascension. Hence, the proper motion of the center of gravity of the system of 9 Argus referred to the comparison stars used will be − 0″.053 in right ascension. Making use of the orbital motion, as shown in the above ephemeris, and comparing the results of the first four plates of the series, 1060 to 1187, inclusive, with the last ten plates taken, and correcting the measures for parallax, it is readily derived that the masses of the components A and B are in the ratio 0.73 to 0.27, where 1.0 represents the total mass of the system.

TABLE 1

PLATES OF 9 PUPPIS

No.	Date.	Hour Angle.	Observers.	Weight.
1060	1915 Mar. 14	+0h8	M	1.0
1135	Mar. 31	+0.4	G	1.0
1186	Apr. 13	+0.9	M	1.0
1187	Apr. 13	+1.3	M	1.0
1864	Oct. 25	−1.0	Ol	0.7
1865	Oct. 25	−0.6	Ol	0.7
2036	Nov. 17	+0.2	A	0.7
2037	Nov. 17	+0.6	A	0.7
2555	1916 Apr. 6	+1.0	M	0.7
2565	Apr. 15	+1.3	Ol	0.5*
3268	Oct. 24	−0.4	M	0.7
3269	Oct. 24	0.0	M	0.7
3718	1917 Mar. 6	+0.2	M	0.8
3719	Mar. 6	+0.6	M	0.8
3791	Mar. 22	+0.1	A	0.8
3792	Mar. 22	+0.2	A	0.8
3868	Apr. 10	+0.9	M	0.7
3871	Apr. 11	+1.0	A	0.8
4710	Nov. 5	−0.8	B	1.0
4711	Nov. 5	−0.4	B	0.9
4733	Nov. 7	−1.4	B	0.8
4734	Nov. 7	−1.0	B	0.8

* One exposure.

TABLE 2

REDUCTIONS FOR 9 PUPPIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1060	−0.0154	1.0	−0.833	−514	−0.0007	−0″.01
1135	− .0162	1.0	− .950	−497	.0000	.00
1186	− .0148	1.0	− .986	−484	− .0015	− .03
1187	− .0198	1.0	− .986	−484	+ .0035	+ .07
1864	− .0134	0.7	+ .971	−289	+ .0014	+ .02
1865	− .0136	0.7	+ .971	−289	+ .0016	+ .03
2036	− .0079	0.7	+ .843	−266	− .0042	− .07
2037	− .0092	0.7	+ .843	−266	− .0029	− .05
2555	− .0150	0.7	− .975	−125	+ .0004	+ .01
2565	− .0168	0.5	− .987	−116	+ .0022	+ .03
3268	− .0132	0.7	+ .971	+ 76	+ .0029	+ .05
3269	− .0099	0.7	+ .971	+ 76	− .0004	− .01
3718	− .0134	0.8	− .758	+209	+ .0007	+ .01
3719	− .0094	0.8	− .758	+209	− .0033	− .06
3791	− .0106	0.8	− .901	+225	− .0022	− .04
3792	− .0124	0.8	− .901	+225	− .0004	− .01
3868	− .0122	0.7	− .983	+244	− .0007	− .01
3871	− .0152	0.8	− .984	+245	+ .0023	+ .04
4710	− .0080	1.0	+ .925	+453	− .0006	− .01
4711	− .0068	0.9	+ .925	+453	− .0018	− .04
4733	− .0086	0.8	+ .914	+455	.0000	.00
4734	−0.0130	0.8	+0.914	+455	+0.0044	+0.08

Assuming the masses to be in this ratio, a second solution was made making allowance for the orbital motion. The parallax resulted + 0″.033 ± 0″.008, differing 0″.003 from the first solution, but the orbital motion from the second solution is found to be − 0″.062 per year, in substantial agreement with the value from Boss.

It is thought that this second solution gives the more reliable value for the parallax. Using the orbit of Lohse, the mass of the system is 11.0 times that of the sun, and the masses of A and B are 7.9⊙ and 3.1⊙ respectively.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−45.2	+21.0	+0.288
2	.12	− 2.2	−19.0	.356
3	.26	+47.4	− 2.0	+0.356
Parallax star	0.18	+ 3.1	− 1.4	

The normal equations are:

$$17.6c - 1.452\mu - 1.9418\pi = -0.2209 \text{ mm.}$$
$$+ 218.3179\mu + 19.1678\pi = +0.1514 \text{ mm.}$$
$$+ 14.9597\pi = +0.0586 \text{ mm.}$$

from which:

$c = -0.01232$ mm.

$\mu = +0.00046$ mm. $= +0''.0096$, or $\pm 0''.035$ per year.

$\pi = +0.00173$ mm. $= +$ **0″.036 ± 0″.008.**

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

ρ PUPPIS ($8^h\ 3^m$; −24° 0′)

This star, also called ι Navis, is of magnitude 2.88, and of type F5. Campbell (*Lick Observatory Bulletin*, **2**, 29, 1903) finds it to be a spectroscopic binary of long period. Mt. Wilson finds the spectroscopic parallax + 0.029. The annual proper motion in right ascension from the present photographs is

$-0''.060$, while Boss gives the value -0.029. Mr. Olivier measured the series of plates.

TABLE 1

PLATES OF ρ PUPPIS

No.	Date.	Hour Angle.	Observers.	Weight.
715	1914 Dec. 26	+0h4	Ol	0.9
723	Dec. 27	+0.7	G	0.6*
751	1915 Jan. 7	+0.3	M	0.8
1016	Mar. 9	0.0	A	1.0
1017	Mar. 9	+0.7	A	0.7*
1038	Mar. 12	0.0	A	1.0
1125	Mar. 29	+0.2	Ol	1.0
1126	Mar. 29	+1.0	Ol	0.8
1897	Oct. 28	−0.5	Ol	0.7
2006	Nov. 10	−0.5	G	0.7
2007	Nov. 10	+0.2	G	0.8
2068	Nov. 25	−0.3	Ol	0.8
3518	1916 Dec. 10	−1.2	L	0.9
3519	Dec. 10	−0.6	L	0.8
3520	Dec. 12	−0.6	M	0.9
3537	Dec. 25	−0.7	L	0.9
3538	Dec. 25	−0.4	L	0.9
3733	1917 Mar. 8	−0.3	L	0.9
3734	Mar. 8	+0.1	L	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−62.3	+22.9	+0.2111
2	.19	−45.2	−37.8	.2071
3	.24	+10.0	+23.3	.1988
4	.11	+41.5	+21.3	.1932
5	.16	+56.0	−29.7	+0.1898
Parallax star	0.20	− 1.9	+ 0.1	

TABLE 2

REDUCTIONS FOR ρ PUPPIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
715	+0.0001	0.9	+0.394	−364	−0.0003	−0″.01
723	+ .0003	0.6	+ .378	−363	− .0005	− .01
751	+ .0002	0.8	+ .249	−352	− .0006	− .01
1016	− .0030	1.0	− .740	−291	+ .0008	+ .02
1017	− .0004	0.7	− .740	−291	− .0018	− .03
1038	− .0030	1.0	− .772	−288	+ .0008	+ .02
1125	− .0044	1.0	− .916	−271	+ .0018	+ .04
1126	− .0011	0.8	− .916	−271	− .0014	− .03
1897	− .0001	0.7	+ .967	− 58	− .0018	− .03
2006	.0000	0.7	+ .916	− 45	− .0020	− .04
2007	− .0032	0.8	+ .916	− 45	+ .0012	+ .02
2068	− .0046	0.8	+ .799	− 30	+ .0023	+ .04
3518	− .0054	0.9	+ .618	+351	− .0001	.00
3519	− .0059	0.8	+ .618	+351	+ .0004	+ .01
3520	− .0036	0.9	+ .592	+353	− .0020	− .04
3537	− .0081	0.9	+ .402	+366	+ .0022	+ .04
3538	− .0070	0.9	+ .402	+366	+ .0011	+ .02
3733	− .0085	0.9	− .734	+439	+ .0006	+ .01
3734	−0.0053	0.8	−0.734	+439	−0.0026	−0.05

The normal equations are:

$$15.9c + 0.899\mu + 0.8511\pi = -0.0557 \text{ mm.}$$
$$+ 155.2975\mu + 9.0734\pi = -0.1138 \text{ mm.}$$
$$+ 7.9076\pi = -0.0002 \text{ mm.}$$

from which:

$c = -0.00353$ mm.

$\mu = -0.00079$ mm. $= -0''.0163$, or $-0''.060$ per year.

$\pi = +0.00126$ mm. $= +\mathbf{0''.026 \pm 0''.008.}$

Probable error of plate of unit weight

$$\pm 0.00098 \text{ mm.} = \pm 0''.020.$$

LALANDE 15950 ($8^h\ 5^m$; $+32°\ 46'$)

This star is of G2 type, of magnitude 6.7, and of total proper motion 0″.82. The parallax has been twice measured. Chase with the Yale heliometer derives the value + 0″.040 ± 0″.042, and Jost with the meridian circle the result + 0″.040 ± 0″.024.

TABLE 1

PLATES OF LALANDE 15950

No.	Date.	Hour Angle.	Observers.	Weight.
3295	1916 Oct. 27	−1ʰ1	M	0.9
3363	Nov. 7	−0.4	L	0.9
3489	Dec. 6	−0.7	A	1.0
3490	Dec. 6	−0.4	A	0.7*
3809	1917 Mar. 25	−0.6	M	0.8
3810	Mar. 25	−0.2	M	0.9
3823	Mar. 28	−0.7	Ol	0.8
3824	Mar. 28	−0.2	Ol	0.7
4629	Oct. 22	−0.4	Ds	0.5*
4636	Oct. 25	−0.8	Ds	0.7
4685	Nov. 2	−0.8	M	0.8
4686	Nov. 2	−0.3	M	0.6
5131	1918 Feb. 23	−0.5	M	0.8
5192	Mar. 11	−0.4	A	0.9
5253	Mar. 30	−0.2	M	1.0
5257	Mar. 31	−0.2	M	1.0
5262	Apr. 2	−0.2	M	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−71.3	+18.1	+0.1855
2	.10	+ 4.8	−21.3	.3054
3	.08	+16.0	+ 0.7	.2524
4	.11	+50.5	+ 2.5	+0.2567
Parallax star	0.14	+ 5.2	− 2.3	

Mr. Alden measured the McCormick plates, and found a proper motion in right ascension of − 0″.456 per year, while the value from Porter is − 0″.454. Mt. Wilson finds the spectroscopic parallax + 0″.072.

TABLE 2

REDUCTIONS FOR LALANDE 15950

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3295	+0.0106	0.9	+0.967	−277	+0.0038	+0″.07
3363	+ .0132	0.9	+ .930	−266	+ .0004	+ .01
3489	+ .0130	1.0	+ .676	−237	− .0016	− .03
3490	+ .0145	0.7	+ .676	−237	− .0031	− .05
3809	+ .0022	0.8	− .886	−128	− .0003	.00
3810	+ .0015	0.9	− .886	−128	+ .0004	+ .01
3823	− .0007	0.8	− .907	−125	+ .0024	+ .04
3824	+ .0050	0.7	− .907	−125	− .0033	− .06
4629	− .0075	0.5	+ .973	+ 83	+ .0003	.00
4636	− .0051	0.7	+ .970	+ 86	− .0023	− .04
4685	− .0066	0.8	+ .952	+ 94	− .0013	− .02
4686	− .0110	0.6	+ .952	+ 94	+ .0031	+ .05
5131	− .0159	0.8	− .558	+207	− .0017	− .03
5192	− .0221	0.9	− .757	+223	+ .0032	+ .06
5253	− .0215	1.0	− .918	+242	+ .0012	+ .02
5257	− .0195	1.0	− .924	+243	− .0009	− .02
5262	−0.0191	0.7	−0.936	+245	−0.0014	−0.02

The normal equations are:

$$13.7c - 0.406\mu - 1.1368\pi = - 0.0556 \text{ mm.}$$
$$+ 53.9172\mu - 10.0071\pi = - 0.3408 \text{ mm.}$$
$$+ 10.4407\pi = + 0.0845 \text{ mm.}$$

from which:

$c = - 0.00408$ mm.

$\mu = - 0.00600$ mm. $= - 0''.1248$, or $- 0''.456$ per year.

$\pi = + 0.00190$ mm. $= + \mathbf{0''.040 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

β CANCRI ($8^h\ 11^m$; $+9°\ 30'$)

This star is of 3.76 magnitude, and of type K2. The trigonometric value of Allegheny is $-0''.003 \pm 0''.009$, while the spectroscopic work of Adams gives the result $+0''.016$. Boss gives the proper motion in right ascension $-0''.052$. The plates of this series were measured by Mr. Olivier, with the exception of the last five plates which were measured by Mr. Mitchell. The proper motion in right ascension from the plates is $-0''.079$, and the relative parallax $-0''.002 \pm 0''.010$.

TABLE 1

PLATES OF β CANCRI

No.	Date.	Hour Angle.	Observers.	Weight.
700	1914 Dec. 22	$+0^h.5$	Ol	0.7
722	Dec. 27	−0.3	G	0.8
992	1915 Mar. 3	−0.2	G	1.0
993	Mar. 3	+0.2	G	1.0
1972	Nov. 5	−0.6	Ol	0.8
1985	Nov. 8	−0.1	Ol	0.9
1986	Nov. 8	+0.4	Ol	0.8
1997	Nov. 9	−0.8	A	1.0
1998	Nov. 9	−0.5	A	1.0
2120	Dec. 6	−0.9	Ol	0.8
2450	1916 Mar. 8	−0.2	G	0.9
2454	Mar. 10	+0.1	Ol	0.9
2480	Mar. 15	+0.4	G	0.7
2498	Mar. 17	+0.4	Ol	1.0
2499	Mar. 17	+0.9	Ol	1.0
5118	1918 Feb. 22	−0.5	Ol	0.6
5119	Feb. 22	+0.1	Ol	0.8
5194	Mar. 15	−0.1	Ol	0.8
5864	Nov. 2	−0.6	M	0.8
5865	Nov. 2	−0.2	M	1.0
5891	Nov. 5	−0.5	M	0.9
5892	Nov. 5	−0.2	M	0.9

TABLE 2

REDUCTIONS FOR β CANCRI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
700	+0.0166	0.7	+0.483	−613	−0.0051	−0″.09
722	+ .0143	0.8	+ .408	−608	− .0028	− .05
992	+ .0137	1.0	− .643	−542	− .0028	− .06
993	+ .0140	1.0	− .643	−542	− .0031	− .06
1972	+ .0068	0.8	+ .946	−295	+ .0014	+ .02
1985	+ .0077	0.9	+ .933	−292	+ .0004	+ .01
1986	+ .0065	0.8	+ .933	−292	+ .0016	+ .03
1997	+ .0072	1.0	+ .929	−291	+ .0009	+ .02
1998	+ .0078	1.0	+ .929	−291	+ .0003	+ .01
2120	+ .0059	0.8	+ .700	−264	+ .0020	+ .04
2450	+ .0051	0.9	− .713	−171	+ .0019	+ .04
2454	+ .0054	0.9	− .736	−169	+ .0016	+ .03
2480	+ .0068	0.7	− .789	−164	+ .0002	.00
2498	+ .0022	1.0	− .809	−162	+ .0048	+ .10
2499	+ .0034	1.0	− .809	−162	+ .0036	+ .07
5118	− .0019	0.6	− .524	+545	+ .0015	+ .02
5119	+ .0032	0.8	− .524	+545	− .0036	− .07
5194	+ .0032	0.8	− .784	+566	− .0038	− .07
5864	− .0033	0.8	+ .955	+798	+ .0001	.00
5865	− .0020	1.0	+ .955	+798	− .0012	− .02
5891	− .0050	0.9	+ .945	+801	+ .0018	+ .04
5892	−0.0022	0.9	+0.945	+801	−0.0010	−0.02

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	− 8.5	+42.0	+0.4374
2	.12	−10.1	−12.1	.1288
3	.14	+18.6	−29.9	+0.4338
Parallax star	0.16	+ 3.05	+ 3.84	

The normal equations are:

$$19.1c - 1.759\mu + 2.7242\pi = + 0.1007 \text{ mm.}$$
$$+ 468.2571\mu + 14.7022\pi = - 0.4981 \text{ mm.}$$
$$+ 12.2522\pi = - 0.0023 \text{ mm.}$$

from which:

$c = + 0.00519$ mm.
$\mu = - 0.00104$ mm. $= - 0''.0217$, or $- 0''.079$ per year.
$\pi = - 0.00009$ mm. $= - \mathbf{0''.002 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00169 \text{ mm.} = \pm 0''.035.$$

LALANDE 16304 (8^h 13^m; $-12°$ 17′)

This star has a total proper motion 1″.03, it is of magnitude 6.3, and of type G9. Its parallax has been determined as follows: Flint by the meridian circle obtained the value + 0″.12 ± 0″.030; Chase with heliometer the result + 0″.095 ± 0″.017; and by photography at Swarthmore, + 0″.075 ± 0″.007. The McCormick plates were measured by Mr. Olivier who determined a relative parallax of + 0″.060 ± 0″.007 with a proper motion in right ascension amounting to + 0″.285 while the corresponding value from Porter is + 0″.279. Mt. Wilson furnishes the spectroscopic parallax of + 0″.123.

TABLE 1

PLATES OF LALANDE 16304

No.	Date.	Hour Angle.	Observers.	Weight.
3410	1916 Nov. 19	-1^h0	L	0.9
3411	Nov. 19	−0.6	L	0.9
3502	Dec. 7	−0.5	M	1.0
3811	1917 Mar. 25	−0.5	M	0.8
3812	Mar. 25	−1.0	M	0.8
3824	Mar. 28	−0.2	Ol	0.7
3825	Mar. 28	+0.1	Ol	0.7
4735	Nov. 7	−0.8	B	0.9
4736	Nov. 7	−0.4	B	0.9
4748	Nov. 9	−0.4	B	1.0
4749	Nov. 9	0.0	B	1.0
5254	1918 Mar. 30	+0.1	M	1.0
5255	Mar. 30	+0.6	M	0.9
5264	Apr. 4	−0.1	A	1.0
5265	Apr. 4	+0.4	A	1.0
5914	Nov. 7	−0.4	F	0.6*
5915	Nov. 7	+0.1	F	0.7
6092	Dec. 17	−0.2	D	1.0
6093	Dec. 17	+0.4	D	1.0
6105	Dec. 18	−0.1	F	1.0
6624	1919 Mar. 4	+0.2	H	0.8
6625	Mar. 4	+0.7	H	0.8
6690	Mar. 18	−0.9	Ol	1.0
6691	Mar. 18	−0.3	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−51.8	+45.8	+0.1557
2	.08	−30.1	−44.7	.1904
3	.09	− 6.5	− 0.9	.1959
4	.10	+33.3	−36.6	.2301
5	.12	+55.1	+36.4	+0.2279
Parallax star	0.10	+ 5.1	− 1.7	

TABLE 2

REDUCTIONS FOR LALANDE 16304

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3410	−0.0020	0.9	+0.864	−489	+0.0011	+0″.02
3411	+ .0014	0.9	+ .864	−489	− .0023	− .05
3502	+ .0032	1.0	+ .685	−471	− .0040	− .08
3811	− .0029	0.8	− .870	−363	+ .0017	+ .03
3812	− .0037	0.8	− .870	−363	+ .0025	+ .05
3824	− .0044	0.7	− .892	−360	+ .0033	+ .06
3825	− .0029	0.7	− .892	−360	+ .0018	+ .03
4735	+ .0116	0.9	+ .937	−136	+ .0010	+ .02
4736	+ .0120	0.9	+ .937	−136	+ .0006	+ .01
4748	+ .0133	1.0	+ .928	−134	− .0007	− .01
4749	+ .0130	1.0	+ .928	−134	− .0004	− .01
5254	+ .0112	1.0	− .904	+ 7	+ .0014	+ .03
5255	+ .0142	0.9	− .904	+ 7	− .0016	− .03
5264	+ .0136	1.0	− .933	+ 12	− .0008	− .02
5265	+ .0160	1.0	− .933	+ 12	− .0032	− .07
5914	+ .0235	0.6	+ .938	+229	+ .0028	+ .04
5915	+ .0261	0.7	+ .938	+229	+ .0002	.00
6092	+ .0254	1.0	+ .562	+269	+ .0013	+ .03
6093	+ .0265	1.0	+ .562	+269	+ .0002	.00
6105	+ .0250	1.0	+ .548	+270	+ .0017	+ .04
6624	+ .0270	0.8	− .648	+346	− .0009	− .02
6625	+ .0256	0.8	− .648	+346	+ .0005	+ .01
6690	+ .0294	1.0	− .805	+360	− .0032	− .07
6691	+0.0258	0.9	−0.805	+360	+0.0004	+0.01

The normal equations are:

$$21.3c - 5.682\mu - 0.1165\pi = + 0.2974 \text{ mm.}$$
$$+ 183.7696\mu - 8.2055\pi = + 0.5825 \text{ mm.}$$
$$+ 14.7132\pi = + 0.0095 \text{ mm.}$$

from which:

$c = + 0.01498$ mm.

$\mu = + 0.00376$ mm. $= + 0''.0782$, or $+ 0''.285$ per year.

$\pi = + 0.00286$ mm. $= \mathbf{+ 0''.060 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00129 \text{ mm.} = \pm 0''.027.$$

LALANDE 17046 (8^h 34^m; $+11°$ 53′)

The spectroscopic parallax determined for this star which has a total proper motion of 0″.52 per year, and of magnitude 8.1 is + 0″.048. Mr. Alden measured the McCormick plates, and found the relative parallax of + 0″.026 ± 0″.009. The proper motion in

TABLE 1

PLATES OF LALANDE 17046

No.	Date.	Hour Angle.	Observers.	Weight.
3338	1916 Nov. 2	−0^h.4	M	0.7
3412	Nov. 19	−0.3	L	0.9
3491	Dec. 6	−0.3	A	1.0
3492	Dec. 6	0.0	A	1.0
3513	Dec. 9	−0.4	Ol	1.0
3797	1917 Mar. 24	+0.1	M	0.8
3798	Mar. 24	+0.4	M, L	0.8
3869	Apr. 10	+0.6	M	0.8
3870	Apr. 10	+1.0	M	0.8
3890	Apr. 18	+0.7	Ol	0.7
3891	Apr. 18	+1.1	Ol	0.7
4660	Oct. 31	−0.8	A	0.8
4771	Nov. 16	−0.7	B	0.8
4772	Nov. 16	−0.3	B	0.8
5217	1918 Mar. 25	−0.2	A	1.0
5218	Mar. 25	+0.2	A	1.0
5232	Mar. 27	0.0	M	1.0
5233	Mar. 27	+0.4	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−44.1	+ 0.6	+0.3366
2	.10	+ 3.4	+11.9	.2767
3	.08	+40.7	−12.5	+0.3867
Parallax star	0.11	+ 1.8	− 1.3	

right ascension from the plates is $-0''.113$ per year, while the value from Porter is $-0''.104$.

TABLE 2

REDUCTIONS FOR LALANDE 17046

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
3338	+0.0073	0.7	+0.958	−234	−0.0033	−0″.06
3412	+ .0026	0.9	+ .891	−217	+ .0010	+ .02
3491	+ .0022	1.0	+ .747	−200	+ .0010	+ .02
3492	+ .0043	1.0	+ .747	−200	− .0011	− .02
3513	+ .0050	1.0	+ .714	−197	− .0019	− .04
3797	+ .0018	0.8	− .814	− 92	− .0022	− .04
3798	− .0039	0.8	− .814	− 92	+ .0035	+ .07
3869	+ .0014	0.8	− .934	− 75	− .0022	− .04
3870	− .0036	0.8	− .934	− 75	+ .0028	+ .05
3890	− .0028	0.7	− .963	− 67	+ .0019	+ .03
3891	− .0018	0.7	− .963	− 67	+ .0009	+ .01
4660	− .0028	0.8	+ .960	+129	+ .0014	+ .02
4771	− .0042	0.8	+ .910	+145	+ .0024	+ .05
4772	− .0022	0.8	+ .910	+145	+ .0004	+ .01
5217	− .0043	1.0	− .820	+274	− .0015	− .03
5218	− .0054	1.0	− .820	+274	− .0004	− .01
5232	− .0038	1.0	− .838	+276	− .0021	− .04
5233	−0.0065	1.0	−0.838	+276	+0.0006	+0.01

The normal equations are:

$$15.6c + 1.181\mu - 1.5565\pi = -0.0151 \text{ mm.}$$
$$+ 57.7802\mu - 10.4990\pi = -0.1002 \text{ mm.}$$
$$+ 11.5485\pi = +0.0313 \text{ mm.}$$

from which:

$c = -0.00073$ mm.

$\mu = -0.00149$ mm. $= -0''.0310$, or $-0''.113$ per year.

$\pi = +0.00126$ mm. $= +$ **0″.026 ± 0″.009.**

Probable error of plate of unit weight

$$\pm 0.00130 \text{ mm.} = \pm 0''.027.$$

δ CANCRI ($8^h\ 39^m$; $+18°\ 31'$)

This star is of magnitude 4.17, and of type K. Adams furnishes the value of the spectroscopic parallax to be $+\ 0''.017$. Allegheny finds the trigonometric parallax $-\ 0''.012 \pm 0''.012$. The total proper motion is $0''.24$, that in right ascension being $-\ 0''.017$. *Burnham's General Catalogue* gives the measures of δ Cancri with respect to a fifteenth magnitude star at a distance of 45″. The change in position angle and distance is entirely due to the proper motion of δ Cancri. Mr. Olivier measured the twenty-one plates of the series, and found the proper motion in right ascension equal $-\ 0''.009$.

TABLE 1

PLATES OF δ CANCRI

No.	Date.	Hour Angle.	Observers.	Weight.
698	1914 Dec. 21	$-0^h.4$	A	0.9
734	1915 Jan. 4	+0.2	G	0.6*
784	Jan. 13	0.0	G	0.8
810	Jan. 20	+0.7	G	0.8
978	Mar. 2	+0.1	M	0.9
1062	Mar. 14	+1.1	M	0.7
1079	Mar. 18	+0.6	Ol	1.0
1080	Mar. 18	+1.1	Ol	1.0
1226	Apr. 18	+0.4	Ol	0.8
1973	Nov. 5	−0.4	Ol	0.9
2013	Nov. 15	−0.9	Ol	0.7
2014	Nov. 15	−0.4	Ol	0.7
2121	Dec. 6	−0.7	Ol	0.7
2122	Dec. 6	−0.1	Ol	0.9
2203	Dec. 22	−0.4	G	0.6*
2204	Dec. 22	0.0	G	0.7
2234	Dec. 26	−0.6	A	1.0
2235	Dec. 26	−0.2	A	0.9
2500	1916 Mar. 17	+1.4	Ol	0.9
2519	Mar. 23	−0.1	Ol	0.8
2520	Mar. 23	+0.3	Ol	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−63.3	0.0	+0.2556
2	.17	−19.2	−42.8	.2236
3	.14	+19.7	+36.9	.2725
4	.17	+62.8	+ 5.9	+0.2483
Parallax star	0.17	+ 0.5	+ 1.9	

TABLE 2

REDUCTIONS FOR δ CANCRI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
698	+0.0050	0.9	+0.585	−249	−0.0015	−0″.03
734	+ .0044	0.6	+ .382	−235	− .0013	− .02
784	+ .0054	0.8	+ .239	−226	− .0025	− .05
810	− .0006	0.8	+ .122	−219	+ .0033	+ .06
978	− .0011	0.9	− .535	−178	+ .0026	+ .05
1062	+ .0029	0.7	− .691	−166	− .0016	− .03
1079	+ .0005	1.0	− .736	−162	+ .0007	+ .01
1080	− .0002	1.0	− .736	−162	+ .0014	+ .03
1226	+ .0030	0.8	− .957	−131	− .0022	− .04
1973	+ .0057	0.9	+ .922	+ 70	− .0012	− .02
2013	+ .0042	0.7	+ .954	+ 80	+ .0003	+ .01
2014	+ .0065	0.7	+ .954	+ 80	− .0020	− .03
2121	+ .0019	0.7	+ .764	+101	+ .0023	+ .04
2122	+ .0018	0.9	+ .764	+101	+ .0024	+ .05
2203	+ .0049	0.6	+ .574	+117	− .0010	− .02
2204	+ .0047	0.7	+ .574	+117	− .0008	− .01
2234	+ .0033	1.0	+ .519	+121	+ .0005	+ .01
2235	+ .0031	0.9	+ .519	+121	+ .0007	+ .01
2501	+ .0044	0.9	− .733	+203	− .0028	− .05
2519	+ .0004	0.8	− .796	+209	+ .0011	+ .02
2520	+0.0012	0.8	−0.796	+209	+0.0003	+ .01

The normal equations are:

$$17.1c - 1.906\mu + 1.0285\pi = + 0.0478 \text{ mm.}$$
$$+ 46.4470\mu + 3.5013\pi = + 0.0066 \text{ mm.}$$
$$+ 8.2717\pi = + 0.0182 \text{ mm.}$$

from which:

$c = + 0.00270$ mm.

$\mu = + 0.00012$ mm. $= + 0''.0024$, or $+ 0''.009$ per year.

$\pi = + 0.00181$ mm. $= + \mathbf{0''.038 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00137 \text{ mm.} = \pm 0''.028.$$

ι CANCRI ($8^h\ 40^m$; $+29°\ 7'$)

This is a wide double, Σ 1268, separated 30″, of magnitudes 4.20 and 6.61 respectively, the brighter star being of type G5. According to Lewis (*Mem. R. A. S.*, **56**, 253), the two stars are to be considered as physically connected. The common value of the parallax as determined by the McCormick plates confirms this idea. The plates were measured by Mr. Mitchell. The rotating sector was used to reduce the size of the parallax stars. Some of the plates were used showing both stars, some in which the sector was still further reduced to diminish the size of the brighter star. The diameters as given below were measured on a plate which showed the two parallax stars. Boss gives the proper motion of the brighter star in right ascension $- 0''.020$ per year. The spectroscopic parallax of the brighter star is $\pm 0''.011$. Combining the two values of the parallax, we derive the parallax of the system to be:

$$\mathbf{+ 0''.028 \pm 0''.004}.$$

Comparison Stars

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				Principal Star.	Companion.
	mm.	mm.	mm.		
1	0.20	−29.6	−45.5	+0.271	+0.268
2	.10	−21.9	+41.9	.408	.427
3	.27	+51.5	+ 3.6	+0.321	+0.305
Brighter star	.30	− 0.4	+ 5.9		
Fainter star	0.12	− 1.6	+ 6.8		

TABLE 1

PLATES OF ι CANCRI

No.	Date.	Hour Angle.	Observers.	Weight.
561	1914 Nov. 11	−0ʰ2	A	0.7
608	Nov. 21	−0.7	M	0.7
620	Nov. 22	−0.5	A	1.0
633	Nov. 23	−0.8	G	0.7
1051	1915 Mar. 13	−0.2	A	0.7
1070	Mar. 17	+0.1	A	0.8
1146	Apr. 4	−0.2	M	0.8
1154	Apr. 7	−0.6	G	0.7
1162	Apr. 8	−0.6	M	0.7*
1163	Apr. 8	−0.1	M, A	1.0
2100	Nov. 30	−0.8	A	1.0
2138	Dec. 9	−0.9	A	0.8
2139	Dec. 9	−0.5	A	1.0
2166	Dec. 18	−0.9	M	1.0
3465	1916 Dec. 1	−1.0	A	0.9
3502	Dec. 7	−0.4	M	0.8
3503	Dec. 7	−0.1	M	0.8
3522	Dec. 12	−0.2	M	0.7*
3529	Dec. 17	−0.8	L	0.7
3530	Dec. 17	−0.4	L	0.7
3756	1917 Mar. 12	−0.7	L	0.8
3757	Mar. 12	−0.3	L	0.8
3780	Mar. 20	−0.8	M	0.6
3797	Mar. 24	−0.8	M	0.8
3798	Mar. 24	−0.5	M	0.8
3810	Mar. 25	−0.4	M	0.8
3827	Mar. 29	−0.4	L	0.9
3828	Mar. 29	−0.1	L	0.9

* One exposure.

The normal equations are:

$$21.0c + 13.634\mu + 13.2636\pi = +0.4370 \text{ mm.}$$
$$+ 240.7185\mu - 6.0411\pi = +0.2098 \text{ mm.}$$
$$+ 13.1145\pi = +0.0447 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR ι CANCRI, BRIGHTER STAR

Pate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
561	+0.0231	0.7	+0.938	−402	+0.0001	0″.00
608	+ .0256	0.7	+ .890	−392	− .0024	− .04
620	+ .0230	1.0	+ .883	−391	+ .0001	.00
633	+ .0204	0.7	+ .877	−390	+ .0027	+ .05
1051	+ .0226	0.7	− .672	−280	− .0017	− .03
1070	+ .0186	0.8	− .718	−276	+ .0022	+ .04
1146	+ .0184	0.8	− .884	−258	+ .0021	+ .04
1154	+ .0222	0.7	− .903	−255	− .0017	− .03
1162	+ .0206	0.7	− .909	−254	− .0001	.00
1163	+ .0192	1.0	− .909	−254	+ .0013	+ .03
2100	+ .0225	1.0	+ .825	− 18	− .0005	− .01
2138	+ .0222	0.8	+ .738	− 9	− .0003	− .01
2139	+ .0248	1.0	+ .738	− 9	− .0029	− .06
2166	+ .0234	1.0	+ .632	0	− .0017	− .04
3465	+ .0203	0.9	+ .809	+349	+ .0007	+ .01
3502	+ .0170	0.8	+ .751	+355	+ .0039	+ .07
3503	+ .0187	0.8	+ .751	+355	+ .0022	+ .04
3522	+ .0192	0.7	+ .694	+360	+ .0016	+ .03
3529	+ .0221	0.7	+ .636	+365	− .0014	− .02
3530	+ .0220	0.7	+ .636	+365	− .0013	− .02
3756	+ .0170	0.8	− .664	+450	+ .0018	+ .03
3757	+ .0188	0.8	− .664	+450	.0000	.00
3780	+ .0193	0.6	− .756	+458	− .0006	− .01
3810	+ .0210	0.8	− .804	+463	− .0024	− .04
3827	+ .0197	0.9	− .842	+467	− .0012	− .02
3828	+0.0186	0.9	−0.842	+467	−0.0001	0.00

from which:

$c = + 0.02092$ mm.

$\mu = - 0.00028$ mm. $= - 0''.0059$, or $- 0''.022$ per year.

$\pi = + 0.00126$ mm. $= + \mathbf{0''.026 \pm 0''.006}$.

Probable error of plate of unit weight

± 0.00112 mm. $= \pm 0''.023$.

TABLE 3

REDUCTIONS FOR ι CANCRI, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
561	+0.0051	0.7	+0.938	−402	−0.0002	0″.00
608	+ .0069	0.7	+ .890	−392	− .0021	− .04
620	+ .0046	1.0	+ .883	−391	+ .0002	.00
633	+ .0054	0.7	+ .877	−390	− .0006	− .01
1051	+ .0046	0.7	− .672	−280	− .0027	− .05
1070	− .0004	0.8	− .718	−276	+ .0022	+ .04
1146	− .0002	0.8	− .884	−258	+ .0017	+ .02
1154	+ .0050	0.7	− .903	−255	− .0035	− .06
1162	− .0005	0.7	− .909	−254	+ .0020	+ .03
1163	− .0010	1.0	− .909	−254	+ .0024	+ .05
2100	+ .0022	1.0	+ .825	− 18	+ .0007	+ .01
2138	+ .0042	0.8	+ .738	− 9	− .0015	− .03
2139	+ .0032	1.0	+ .738	− 9	− .0005	− .01
2166	+ .0030	1.0	+ .632	0	− .0005	− .01
3465	+ .0018	0.9	+ .809	+349	− .0007	− .01
3502	+ .0003	0.8	+ .751	+355	+ .0007	+ .01
3503	.0000	0.8	+ .751	+355	+ .0010	+ .02
3522	− .0018	0.7	+ .694	+360	+ .0026	+ .05
3529	− .0012	0.7	+ .636	+365	+ .0019	+ .03
3797	+ .0003	0.8	− .794	+462	− .0022	− .04
3798	− .0016	0.8	− .794	+462	− .0002	.00
3810	− .0002	0.8	− .804	+463	− .0017	− .03
3828	−0.0020	0.9	−0.842	+467	+0.0001	0.00

The normal equations are:

$$18.8c + 4.320\mu + 1.8218\pi = + 0.0302 \text{ mm.}$$
$$+ 200.9299\mu - 3.1381\pi = - 0.0953 \text{ mm.}$$
$$+ 12.1536\pi = + 0.0224 \text{ mm.}$$

from which:

$c = + 0.00157$ mm.

$\mu = - 0.00048$ mm. $= - 0''.0101$, or $- 0''.037$ per year.

$\pi = + 0.00148$ mm. $= + \mathbf{0''.031} \pm \mathbf{0''.006}$.

Probable error of plate of unit weight

18 ± 0.00107 mm. $= \pm 0''.022$.

ϵ HYDRÆ ($8^h\ 41^m$; $+6°\ 47'$)

This forms a system of more than ordinary interest. Almost from the time of discovery in 1888, it has been found that the star called AB of ϵ Hydræ formed a binary system in rapid motion. In *Lick Observatory Publications*, **12**, 58, 1914, Aitken finds a period of 15.3 years. The pair is never separated more than 0".25, and the magnitudes of A and B are 3.9 and 4.4 respectively. About 3" distant from this close pair AB is a star of 7.8 magnitude, forming with AB the double star Σ 1273. This Struve companion is in slow direct motion about the brighter pair, and according to Burnham, must have a period in the neighborhood of 650 years. There is still another star 20" distant, and with the same proper motion as the other three stars, and consequently, must belong to the same system. We thus have a quadruple system. To add to the interest, Curtis (*Lick Observatory Bulletin*, **1**, 23, 1901) has found ϵ Hydræ to be a spectroscopic binary with the velocity of the center of gravity + 36.8 km. The total proper motion of these stars is 0".20 per year.

In discussing the orbit, Aitken has the unique opportunity of deriving the orbit from both visual and spectrographic measures. Assuming the correctness of Seeliger's mass ratio, he finds the mean distance between the two components to be 1,359,000,000 km., the parallax of the system + 0".025, and its mass 3.33 of the sun's mass. By photography, at Swarthmore the parallax of − 0".002 ± 0".011 has been found, and at Allegheny the value + 0".026 ± 0".009. Adams by the spectroscopic method finds the parallax of + 0".041 for the pair.

The present series of plates were reduced without making allowance for the orbital motion. The mean of the times when the plates were taken was 1916.28, which from Aitken's ephemeris, corresponds to a position angle of the component of 14°.4 and to a distance 0".08. Since the series of photographs were symmetrical with respect to this time, the orbital motion should have little effect on the parallax. The rotating sector was used to reduce the brightness of the parallax star in the present series of plates. Boss finds the proper motion in right ascension of the

TABLE 1

PLATES OF ϵ HYDRÆ

No.	Date.	Hour Angle.	Observers.	Weight.
954	1915 Feb. 26	0^h0	G	0.7
1004	Mar. 8	+0.4	G	0.5
1136	Mar. 31	0.0	G	1.0
1172	Apr. 9	+0.8	G	1.0
1963	Nov. 3	−0.2	G	0.4*
2008	Nov. 10	+0.1	G	0.7
2027	Nov. 16	+0.1	G	0.7
2152	Dec. 10	0.0	G	0.5*
2482	1916 Mar. 15	+1.2	G	0.6
2521	Mar. 23	+1.0	Ol	0.7
2539	Mar. 31	−0.2	G	0.6
3318	Oct. 31	−0.9	L	0.7
3319	Oct. 31	−0.5	L	1.0†
3327	Nov. 1	−1.0	A	0.9
3328	Nov. 1	−0.6	A	1.0
3364	Nov. 7	−0.3	L	1.0
3365	Nov. 7	+0.1	L	1.0
3739	1917 Mar. 9	+1.1	Ol	0.9
3847	Apr. 5	−0.1	A	0.7*
3849	Apr. 7	+0.6	A	0.6*
3850	Apr. 7	+1.0	A	0.8

* One exposure. † Three exposures.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−38.3	+29.4	+0.2193
2	.16	−35.9	+ 3.4	.2193
3	.12	− 4.7	+17.3	.2017
4	.22	+ 5.3	−40.0	.1993
5	.22	+73.6	−10.1	+0.1604
Parallax star	0.19	− 4.4	+ 1.1	

center of gravity of the system to be − 0″.189 per year, while the McCormick plates give the value of − 0″.177. The solar drift should cause a motion of the comparison stars which, in right ascension, will amount to approximately − 0″.010. Hence, the proper motion from the McCormick plates referred to the equator instead of to the system of comparison stars used, will amount to − 0″.187 per year. The photographic plates give the proper motion of the center of brightness. But there is little difference between the magnitude of the components, and it would therefore seem from the agreement between the proper motion of the center of brightness and the center of gravity

TABLE 2

REDUCTIONS FOR ϵ HYDRÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
954	−0.0042	0.7	−0.468	−423	+0.0043	+0″.07
1004	− .0034	0.5	− .607	−393	+ .0027	+ .04
1136	+ .0002	1.0	− .852	−370	− .0014	− .03
1172	+ .0020	1.0	− .914	−361	− .0035	− .07
1963	− .0067	0.4	+ .957	−153	+ .0008	+ .01
2008	− .0043	0.7	+ .942	−146	− .0018	− .03
2027	− .0062	0.7	+ .919	−140	− .0001	.00
2152	− .0044	0.5	+ .728	−116	− .0024	− .04
2482	− .0118	0.6	− .703	− 20	+ .0024	+ .04
2521	− .0091	0.7	− .788	− 12	− .0005	− .01
2539	− .0131	0.6	− .858	− 4	+ .0033	+ .05
3318	− .0189	0.7	+ .958	+210	+ .0045	+ .08
3319	− .0111	1.0	+ .958	+210	− .0033	− .07
3327	− .0113	0.9	+ .958	+211	− .0031	− .06
3328	− .0144	1.0	+ .958	+211	.0000	.00
3364	− .0150	1.0	+ .948	+217	+ .0004	+ .01
3365	− .0182	1.0	+ .948	+217	+ .0036	+ .07
3739	− .0178	0.9	− .627	+339	.0000	.00
3847	− .0174	0.7	− .893	+366	− .0010	− .02
3849	− .0191	0.6	− .906	+368	+ .0006	+ .01
3850	−0.0172	0.8	−0.906	+368	−0.0013	−0.02

that the two components must be of nearly equal mass. The McCormick value of the parallax requires a separation between A and B of 25 times the distance between the earth and the sun, with a consequent mass of the system of 71.3 times that of the sun. The plates of the series were measured by Mr. Alden.

The normal equations are:

$$16.0c + 7.026\mu + 1.0512\pi = -0.1715 \text{ mm.}$$
$$+ 115.5309\mu + 8.8368\pi = -0.3359 \text{ mm.}$$
$$+ 12.0780\pi = -0.0284 \text{ mm.}$$

from which:

$c = -0.00971$ mm.

$\mu = -0.00232$ mm. $= -0''.0485$, or $-0''.177$ per year.

$\pi = +0.00020$ mm. $= +\mathbf{0''.004 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00156 \text{ mm.} = \pm 0''.032.$$

53 CANCRI ($8^h\ 46^m$; $+28°\ 38'$)

55 CANCRI ($8^h\ 46^m$; $+28°\ 43'$)

53 Cancri is of small proper motion $0''.02$, while 55 Cancri has a total proper motion of $0''.55$ per year. 53 Cancri is of magnitude 6.31 and type Mb, and 55 Cancri is of magnitude 6.06 and of type K5. The same series of photographs was utilized to derive the parallaxes of both stars. These plates were measured by Mr. Olivier except the three last measured by Mr. Mitchell. The only trigonometric value of the parallax of 53 Cancri is that of van Maanen who derives the relative parallax of $-0''.001 \pm 0''.009$. The McCormick value is in good agreement with this, since it amounts to $-0''.005 \pm 0''.012$. The McCormick proper motion is $+0''.002$ in right ascension, while the corresponding value from Boss is $-0''.016$.

Three values of the parallax of 55 Cancri have been published: $+0''.086 \pm 0''.037$ by Jost with the meridian circle, $+0''.057 \pm 0''.038$ by Chase with the heliometer, and $+0''.069 \pm 0''.006$ by photography at Allegheny. The McCormick relative parallax is $+0''.076 \pm 0''.011$. The proper motion in right ascension from the plates is $-0''.523$ while the value from Boss amounts to $-0''.481$. Mt. Wilson by the spectrograph finds the parallax is $+0''.010$ and $+0''.100$ for 53 and 55 Cancri, respectively.

TABLE 1

PLATES OF 53 AND 55 CANCRI

No.	Date.	Hour Angle.	Observers.	Weight.
3395	1916 Nov. 16	−0h6	M	1.0
3396	Nov. 16	−0.2	M	0.8
3428	Nov. 21	−0.7	L	0.9
3429	Nov. 21	−0.2	L	0.8
3873	1917 Apr. 13	−0.1	M	0.9
3883	Apr. 14	0.0	M	0.9
4673	Nov. 1	−0.5	Ds	0.8
4674	Nov. 1	−0.1	Ds	0.7
4693	Nov. 3	−0.8	Ds	0.8
4694	Nov. 3	−0.4	Ds	0.8
5220	1918 Mar. 26	−0.9	Ol	0.8
5274	Apr. 5	−0.6	M	1.0
5275	Apr. 6	−0.6	M	1.0
5276	Apr. 6	−0.1	M	0.9
5965	Nov. 13	−0.9	M	1.0
5966	Nov. 13	−0.6	M	1.0
5967	Nov. 13	−0.2	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				55	53
	mm.	mm.	mm.		
1	0.12	−64.9	−36.1	+0.3741	+0.3556
2	.13	− 9.3	−45.7	.2290	.0982
3	.15	+20.2	+47.7	.2463	.3673
4	.13	+54.0	+34.1	+0.1506	+0.1789
55 Cancri	.12	−13.3	− 7.1		
53 Cancri	0.14	− 6.9	+ 6.3		

TABLE 2

REDUCTIONS FOR 53 CANCRI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3395	−0.0013	1.0	+0.919	−347	−0.0004	−0″.01
3396	− .0062	0.8	+ .919	−347	+ .0045	+ .09
3428	− .0022	0.9	+ .893	−342	+ .0006	+ .01
3429	− .0028	0.8	+ .893	−342	+ .0012	+ .02
3873	+ .0026	0.9	− .929	−199	− .0038	− .07
3883	− .0008	0.9	− .934	−198	− .0004	− .01
4673	+ .0032	0.8	+ .956	+ 3	− .0048	− .09
4674	− .0024	0.7	+ .956	+ 3	+ .0008	+ .01
4693	+ .0014	0.8	+ .955	+ 5	− .0030	− .05
4694	− .0020	0.8	+ .955	+ 5	+ .0004	+ .01
5220	+ .0036	0.8	− .798	+148	− .0047	− .09
5274	− .0009	1.0	− .880	+158	− .0002	.00
5275	− .0039	1.0	− .887	+159	+ .0028	+ .06
5276	− .0062	0.9	− .887	+159	+ .0051	+ .10
5965	− .0017	1.0	+ .934	+380	+ .0003	+ .01
5966	+ .0002	1.0	+ .934	+380	− .0016	− .03
5967	−0.0036	1.0	+0.934	+380	+0.0022	+0.05

The normal equations are:

$$15.1c + 1.677\mu + 4.0559\pi = -0.0211 \text{ mm.}$$
$$+ 101.0274\mu - 1.8516\pi = +0.0013 \text{ mm.}$$
$$+ 12.6636\pi = -0.0085 \text{ mm.}$$

from which:

$c = -0.00133$ mm.

$\mu = +0.00003$ mm. $= +0''.0006$, or $+0''.002$ per year.

$\pi = -0.00024$ mm. $= -$ **0″.005 ± 0″.012.**

Probable error of plate of unit weight

$$\pm 0.00192 \text{ mm.} = \pm 0''.040.$$

TABLE 3

REDUCTIONS FOR 55 CANCRI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3395	−0.0102	1.0	+0.919	−347	+0.0009	+0″.02
3396	− .0069	0.8	+ .919	−347	− .0024	− .04
3428	− .0084	0.9	+ .893	−342	− .0013	− .03
3429	− .0132	0.8	+ .893	−342	+ .0035	+ .06
3873	− .0250	0.9	− .929	−199	− .0012	− .02
3883	− .0272	0.9	− .934	−198	+ .0009	+ .02
4673	− .0300	0.8	+ .956	+ 3	− .0033	− .06
4674	− .0378	0.7	+ .956	+ 3	+ .0045	+ .08
4693	− .0321	0.8	+ .955	+ 5	− .0013	− .02
4694	− .0334	0.8	+ .955	+ 5	.0000	.00
5220	− .0454	0.8	− .798	+148	− .0043	− .08
5274	− .0498	1.0	− .880	+158	− .0008	− .02
5275	− .0530	1.0	− .887	+159	+ .0022	+ .05
5276	− .0531	0.9	− .887	+159	+ .0024	+ .05
5965	− .0628	1.0	+ .934	+380	+ .0034	+ .07
5966	− .0558	1.0	+ .934	+380	− .0036	− .07
5967	−0.0597	1.0	+0.934	+380	+0.0003	+0.01

The normal equations are:

$$15.1c + 1.677\mu + 4.0559\pi = -0.5489 \text{ mm.}$$
$$+ 101.0274\mu - 1.8516\pi = -0.7646 \text{ mm.}$$
$$+ 12.6636\pi = -0.0895 \text{ mm.}$$

from which:

$c = -0.03656$ mm.

$\mu = -0.00689$ mm. $= -0''.1434$, or $-0''.523$ per year.

$\pi = +0.00364$ mm. $= +\mathbf{0''.076 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00174 \text{ mm.} = \pm 0''.036.$$

ζ HYDRÆ (8^h 50^m; $+6°$ 19′)

Two parallax values have been published for this star which are of magnitude 3.30, and of type K. The Allegheny result from photography is $+0''.024 \pm 0''.008$, and the spectroscopic value $+0''.019$. Mr. Alden measured the series of plates, and

the measures give a proper motion in right ascension of $-0''.105$, while Boss finds a corresponding value of $-0''.103$.

TABLE 1

PLATES OF ζ HYDRÆ

No.	Date.	Hour Angle.	Observers.	Weight.
505	1914 Nov. 4	$-0^h.4$	M	0.9
537	Nov. 9	−0.1	G	0.8
562	Nov. 11	+0.3	A	0.9
668	Dec. 14	0.0	M	0.7*
1039	1915 Mar. 12	0.0	A	1.0
1040	Mar. 12	+0.6	A	0.7*
1053	Mar. 13	+0.6	A	1.0
1164	Apr. 8	+0.4	A	0.8
1165	Apr. 8	+0.9	A	0.9
1957	Nov. 2	−0.9	A	0.8
1958	Nov. 2	−0.5	A	0.9
2216	Dec. 23	−0.5	A	0.9
2217	Dec. 23	−0.2	A	0.9
2490	1916 Mar. 16	−0.2	A	1.0
2491	Mar. 16	+0.2	A	0.9
2525	Mar. 25	+0.1	A	1.0
2526	Mar. 25	+0.6	A	0.9
3455	Nov. 30	0.0	M	1.0
3456	Nov. 30	+0.3	M	1.0
3467	Dec. 1	−0.2	A	1.0
3468	Dec. 1	+0.4	A	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−33.5	+32.6	+0.1983
2	.10	−29.7	−34.4	.2528
3	.10	−18.5	+23.2	.1946
4	.20	+ 7.1	+33.3	.1658
5	.13	+74.6	−54.7	+0.1885
Parallax star	0.19	− 2.5	− 2.5	

TABLE 2

REDUCTIONS FOR ζ HYDRÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
505	+0.0026	0.9	+0.954	−259	+0.0044	+0″.09
537	+ .0107	0.8	+ .946	−254	− .0038	− .07
562	+ .0086	0.9	+ .942	−252	− .0017	− .03
668	+ .0022	0.7	+ .702	−219	+ .0042	+ .07
1039	+ .0032	1.0	− .639	−131	+ .0020	+ .04
1040	+ .0004	0.7	− .639	−131	+ .0048	+ .08
1053	+ .0084	1.0	− .642	−130	− .0032	− .07
1164	+ .0073	0.8	− .893	−104	− .0025	− .04
1165	+ .0059	0.9	− .893	−104	− .0011	− .02
1957	+ .0012	0.8	+ .955	+104	+ .0007	+ .01
1958	+ .0041	0.9	+ .955	+104	− .0022	− .04
2216	+ .0026	0.9	+ .595	+155	− .0014	− .03
2217	+ .0029	0.9	+ .595	+155	− .0016	− .03
2490	+ .0006	1.0	− .688	+239	− .0006	− .01
2491	+ .0004	0.9	− .688	+239	− .0004	− .01
2525	− .0002	1.0	− .785	+248	+ .0001	.00
2526	− .0025	0.9	− .785	+248	+ .0024	+ .05
3455	− .0045	1.0	+ .834	+498	+ .0010	+ .02
3456	− .0051	1.0	+ .834	+498	+ .0016	+ .03
3467	− .0024	1.0	+ .826	+499	− .0012	− .02
3468	−0.0037	0.8	+0.826	+499	+0.0002	0.00

The normal equations are:

$$18.8c + 19.294\mu + 2.7588\pi = + 0.0364 \text{ mm.}$$
$$+ 149.8402\mu + 8.7289\pi = - 0.1436 \text{ mm.}$$
$$+ 12.0177\pi = - 0.0027 \text{ mm.}$$

from which:

$c = + 0.00336$ mm.

$\mu = - 0.00139$ mm. $= - 0''.0289$, or $- 0''.105$ per year.

$\pi = + 0.00002$ mm. $= \mathbf{0''.000 \pm 0''.010}$.

Probable error of plate of unit weight

$$= \pm 0.00158 \text{ mm.} = \pm 0''.033.$$

38 LYNCIS ($9^h\ 12^m$; $+37°\ 13'$)

This is a double Σ 1334, the brighter star having a magnitude 3.82 and being of A type, and the companion of magnitude 6.6. There is no relative change. The stars have a common proper motion 0″.122. Miss Darkow measured the plates with the exception of the four last measured by Mr. Mitchell. A parallax + 0″.039 ± 0″.010 resulted, and a proper motion in right ascension + 0″.016 where the corresponding value from Boss is −0″.026. Allegheny Observatory has determined the photograph parallax + 0″.026 ± 0″.008.

TABLE 1

PLATES OF 38 LYNCIS

No.	Date.	Hour Angle.	Observers.	Weight.
2297	1916 Jan. 8	−0ʰ4	M	0.7
2308	Jan. 13	−0.6	M	0.4*
3874	1917 Apr. 13	−0.1	M	0.8
3884	Apr. 14	−0.1	A	0.8
4762	Nov. 10	−0.7	Ds	0.5*
4763	Nov. 10	−0.4	Ds	0.5*
6039	Nov. 30	−0.3	M	0.7
6106	Dec. 18	−0.3	F	0.8
6179	1919 Jan. 6	−1.0	F	0.7*
6180	Jan. 6	−0.6	F	1.0
6202	Jan. 8	−0.2	H	0.8
6656	Mar. 11	−1.1	H	0.7
6657	Mar. 11	−0.7	H	0.8
6712	Mar. 21	−0.5	D	1.0
6713	Mar. 21	+0.1	D	1.0
6753	Mar. 25	−0.6	D	1.0
6754	Mar. 25	−0.2	D	1.0
8124	Nov. 20	−0.8	F	1.0
8125	Nov. 20	−0.4	F	1.0
8143	Nov. 26	−0.6	M	0.6*
8144	Nov. 26	−0.1	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR 38 LYNCIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
2297	+0.0040	0.7	+0.445	−969	−0.0007	−0″.01
2308	+ .0009	0.4	+ .370	−964	+ .0023	+ .03
3874	+ .0028	0.8	− .885	−508	− .0010	− .02
3884	+ .0049	0.8	− .891	−507	− .0031	− .06
4762	+ .0050	0.5	+ .944	−297	+ .0007	+ .01
4763	.0000	0.5	+ .944	−297	+ .0057	+ .08
6039	+ .0093	0.7	+ .870	+ 88	− .0029	− .05
6106	+ .0065	0.8	+ .713	+106	− .0004	− .01
6179	+ .0064	0.7	+ .470	+125	− .0007	− .01
6180	+ .0062	1.0	+ .470	+125	− .0005	− .01
6202	+ .0050	0.8	+ .441	+127	+ .0007	+ .01
6656	+ .0004	0.7	− .537	+189	+ .0036	+ .06
6657	+ .0038	0.8	− .537	+189	+ .0002	.00
6712	+ .0013	1.0	− .666	+199	+ .0024	+ .05
6713	+ .0016	1.0	− .666	+199	+ .0022	+ .05
6753	+ .0040	1.0	− .712	+203	− .0003	− .01
6754	+ .0066	1.0	− .712	+203	− .0029	− .06
8124	+ .0094	1.0	+ .922	+443	− .0022	− .05
8125	+ .0081	1.0	+ .922	+443	− .0009	− .02
8143	+ .0079	0.6	+ .895	+449	− .0007	− .01
8144	+0.0054	1.0	+ .895	+449	+0.0018	+0.04

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−60.0	+23.8	+0.223
2	.13	−51.4	−39.4	.174
3	.19	+13.8	−51.7	.159
4	.22	+27.3	+34.5	.224
5	.17	+70.3	+32.8	+0.220
Parallax star	0.15	+ 1.46	+5.17	

The normal equations are:

$$16.8c + 9.795\mu + 2.0284\pi = + 0.0827 \text{ mm.}$$
$$+ 251.3427\mu + 10.0839\pi = + 0.1170 \text{ mm.}$$
$$+ 9.1292\pi = + 0.0284 \text{ mm.}$$

from which:

$c = + 0.00457$ mm.

$\mu = + 0.00021$ mm. $= + 0''.0044$, or $+ 0''.016$ per year.

$\pi = + 0.00186$ mm. $= +$ **0″.039** $\pm$ **0″.010.**

Probable error of plate of unit weight

$$\pm 0.00134 \text{ mm.} = \pm 0''.028.$$

λ LEONIS (9^h 26^m; $+23°$ 24′)

No other parallax has been published for this star which is of magnitude 4.48, of spectral type K5p, and of small proper motion than the spectroscopic parallax of Adams and Joy $\pm 0''.011$. Mr. Alden measured the McCormick plates with the exception of the three last plates measured by Mr. Mitchell. The proper motion in right ascension from the plates is $- 0''.009$ while the corresponding value from Boss is $- 0''.023$.

TABLE 1

PLATES OF λ LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
2140	1915 Dec. 9	−0h5	A	0.6
2254	1916 Jan. 2	−1.3	G	0.8
2255	Jan. 2	−1.0	G	0.8
2274	Jan. 3	−0.7	Ol	0.7
2567	Apr. 17	−0.2	G	0.7
2568	Apr. 17	+0.2	G	0.8
3569	1917 Jan. 9	−1.0	L	0.9
3570	Jan. 9	−0.6	L	0.9
3772	Mar. 19	+0.7	Ol	0.8
3773	Mar. 19	+0.7	Ol	0.8
3915	Apr. 26	+0.4	A	0.8
3916	Apr. 26	+0.8	A	0.8
4713	Nov. 5	−0.9	B	0.8
4725	Nov. 6	−0.9	Ds	0.6*
4750	Nov. 9	−0.7	B	1.0
4773	Nov. 16	−0.6	B	1.0
4786	Nov. 17	+0.3	Ds	0.8
4832	Dec. 1	−0.6	B	0.8
4833	Dec. 1	−0.2	B	0.8
5256	1918 Mar. 30	0.0	M	0.8
5277	Apr. 6	+0.2	M	0.7*
5278	Apr. 14	+0.2	M	1.0
5279	Apr. 14	+0.7	M	1.0
5293	Apr. 15	−0.2	A	1.0
5866	Nov. 2	−1.0	M	0.9
5893	Nov. 5	−1.0	M	1.0
5894	Nov. 5	−0.7	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR λ LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2140	+0.0018	0.6	+0.827	−573	+0.0007	+0″.01
2254	+ .0046	0.8	+ .572	−549	− .0025	− .05
2255	+ .0047	0.8	+ .572	−549	− .0026	− .05
2274	+ .0003	0.7	+ .559	−548	+ .0018	+ .03
2567	− .0018	0.7	− .886	−443	+ .0014	+ .02
2568	+ .0008	0.8	− .886	−443	− .0012	− .02
3569	− .0012	0.9	+ .465	−176	+ .0027	+ .05
3570	− .0022	0.9	+ .465	−176	+ .0037	+ .07
3772	− .0004	0.8	− .603	−107	+ .0001	.00
3773	− .0036	0.8	− .603	−107	+ .0033	+ .06
3915	− .0017	0.8	− .931	− 69	+ .0008	+ .01
3916	− .0008	0.8	− .931	− 69	− .0001	.00
4713	− .0001	0.8	+ .936	+124	+ .0020	+ .04
4725	+ .0041	0.6	+ .938	+125	− .0022	− .04
4750	+ .0027	1.0	+ .940	+128	− .0008	− .02
4773	+ .0048	1.0	+ .935	+135	− .0030	− .06
4786	+ .0016	0.8	+ .933	+136	+ .0002	.00
4832	+ .0014	0.8	+ .878	+150	+ .0003	+ .01
4833	+ .0064	0.8	+ .878	+150	− .0047	− .09
5256	− .0014	0.8	− .729	+269	+ .0004	+ .01
5277	+ .0009	0.7	− .798	+276	− .0020	− .04
5278	+ .0020	1.0	− .863	+284	− .0032	− .07
5279	− .0002	1.0	− .863	+284	− .0010	− .02
5293	− .0029	1.0	− .870	+285	+ .0017	+ .04
5866	+ .0001	0.9	+ .930	+486	+ .0013	+ .03
5893	+ .0036	1.0	+ .936	+489	− .0022	− .05
5894	−0.0037	1.0	+0.936	+489	+0.0051	+0.11

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−16.8	+40.5	+0.2940
2	.09	−13.2	−32.9	.2524
3	.10	+30.0	− 7.6	+0.4536
Parallax star	0.13	+ 5.3	+ 0.2	

The normal equations are:

$$22.6c + 5.941\mu + 3.1653\pi = + 0.0156 \text{ mm.}$$
$$+ 241.7167\mu + 6.4123\pi = - 0.0157 \text{ mm.}$$
$$+ 15.2522\pi = + 0.0254 \text{ mm.}$$

from which:

$c = + 0.00050$ mm.
$\mu = - 0.00012$ mm. $= - 0''.0025$ or $- 0''.009$ per year.
$\pi = + 0.00161$ mm. $= + \mathbf{0''.034 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00154 \text{ mm.} = \pm 0''.032.$$

θ URSÆ MAJORIS ($9^h\ 26^m$; $+52°\ 7'$)

A star of 3.26 magnitude, and type F8, accompanied by a star of 13.7 magnitude, and at a distance of 5″. It has a large proper motion of 1″.09 per year. Several determinations have been made of the parallax as follows: Kapteyn by meridian circle obtains the value $+ 0''.052 \pm 0''.026$, Peter by the heliometer derives the value $+ 0''.09 \pm 0''.018$, while Flint and Abetti by the meridian circle find the values $+ 0''.09 \pm 0''.030$, and $+ 0''.103 \pm 0''.038$, respectively. Allegheny derives the parallax by photography $+ 0''.057 \pm 0''.009$. Adams by the spectroscopic method gives the parallax $+ 0''.110$. The McCormick value, derived by plates measured by Mr. Mitchell gives a value smaller than any of the above, viz. $+ 0''.032 \pm 0''.008$. The proper motion in right ascension as determined by Boss is $- 0''.945$ per year, while that from the present series of plates is $- 0''.952$.

TABLE 1

PLATES OF θ URSÆ MAJORIS

No.	Date.	Hour Angle.	Observers.	Weight.
1114	1915 Mar. 27	−0h2	A	1.0
1150	Apr. 6	−0.6	M	0.9
1216	Apr. 17	−0.4	A	1.0
1230	Apr. 23	0.0	M	0.8
2158	Dec. 14	−0.4	M	0.7
2159	Dec. 14	0.0	M	0.7
2168	Dec. 18	−0.7	M	0.9
2169	Dec. 18	−0.3	M	0.6
2289	1916 Jan. 7	−0.9	Ol	0.6
2290	Jan. 7	−0.1	Ol	0.6
2556	Apr. 6	−0.1	M	0.9
2577	Apr. 19	−0.2	Ol	0.7
2581	Apr. 20	0.0	G	0.6
3397	Nov. 16	−0.1	M	0.7*
3412	Nov. 19	−0.6	L	1.0
3413	Nov. 19	−0.1	L	0.9
3430	Nov. 21	−0.1	L	0.8
3527	Dec. 13	−0.4	A	0.8
3531	Dec. 17	−0.6	L	0.8
3532	Dec. 17	−0.1	L	1.0
3539	Dec. 25	−1.1	L	0.8
3540	Dec. 25	−0.6	L	0.9
3840	1917 Apr. 3	−0.2	L	1.0
3903	Apr. 20	−0.2	Ol	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−22.0	+17.9	+0.209
2	.18	−17.9	−16.6	.257
3	.11	+15.5	+45.3	.204
4	.08	+24.4	−46.6	+0.330
Parallax star	0.18	+ 2.0	− 6.7	

TABLE 2

REDUCTIONS FOR θ URSÆ MAJORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1114	+0.0282	1.0	−0.692	−366	−0.0019	−0″.04
1150	+ .0224	0.9	− .795	−356	+ .0025	+ .05
1216	+ .0238	1.0	− .881	−345	− .0004	− .01
1230	+ .0226	0.8	− .915	−339	.0000	.00
2158	− .0024	0.7	+ .785	−104	− .0019	− .03
2159	− .0076	0.7	+ .785	−104	+ .0033	+ .06
2168	− .0032	0.9	+ .747	−100	− .0016	− .03
2169	− .0062	0.6	+ .747	−100	+ .0014	+ .02
2289	− .0056	0.6	+ .506	− 80	− .0021	− .03
2290	− .0044	0.6	+ .506	− 80	− .0033	− .05
2556	− .0212	0.9	− .802	+ 10	+ .0002	.00
2577	− .0268	0.7	− .898	+ 23	+ .0040	+ .07
2581	− .0224	0.6	− .903	+ 24	− .0005	− .01
3397	− .0469	0.7	+ .935	+234	+ .0005	+ .01
3412	− .0477	1.0	+ .928	+237	+ .0009	+ .02
3413	− .0490	0.9	+ .928	+237	+ .0022	+ .04
3430	− .0494	0.8	+ .922	+239	+ .0024	+ .04
3527	− .0476	0.8	+ .780	+261	− .0024	− .05
3531	− .0480	0.8	+ .750	+265	− .0026	− .05
3532	− .0506	1.0	+ .750	+265	.0000	.00
3539	− .0502	0.8	+ .663	+273	− .0015	− .03
3540	− .0538	0.9	+ .663	+273	+ .0021	+ .04
3840	− .0654	1.0	− .771	+372	− .0009	− .02
3903	−0.0673	0.7	−0.902	+389	−0.0013	−0.02

The normal equations are:

$$19.4c + 9.448\mu + 2.7680\pi = -0.4730 \text{ mm.}$$
$$+ 124.0265\mu + 17.9369\pi = -1.7016 \text{ mm.}$$
$$+ 12.4719\pi = -0.2568 \text{ mm.}$$

from which:

$c = -0.01850$ mm.

$\mu = -0.01253$ mm. $= -0''.2607$, or $-0''.952$ per year.

$\pi = +0.00154$ mm. $= +\mathbf{0''.032 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

o LEONIS ($9^h\ 35^m$; $+10°\ 21'$)

This star of magnitude 3.76, and of type F5p has been found by Campbell (*Astrophysical Journal*, 8, 291, 1898) to be a spectroscopic binary, with a velocity of the center of gravity of the system equal to 27 km. Adams has found the absolute parallax from spectroscopic measurements to be + 0″.011, while Allegheny derived the relative parallax + 0″.024 ± 0″.008 Mr. Alden measured the series of plates, and determined the proper motion in right ascension, − 0″.113 per year while the value from Boss is − 0″.145.

TABLE 1

PLATES OF o_{14} LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
794	1915 Jan. 14	−0h6	M	0.7
807	Jan. 19	−0.4	Ol	0.9
1166	Apr. 8	+0.7	A	1.0
1188	Apr. 13	+0.3	M	0.8
1189	Apr. 13	+0.8	M	0.9
1227	Apr. 19	+0.3	Ol	0.8
2038	Nov. 17	−0.6	A	1.0
2039	Nov. 17	−0.1	A	0.9
2060	Nov. 24	+0.2	G	0.7
2218	Dec. 23	−0.3	A	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−52.7	+20.8	+0.3488
2	.14	+ 6.8	−35.7	.2518
3	.14	+45.9	+14.9	+0.3994
Parallax star	0.16	+ 1.7	+ 4.2	

TABLE 2

REDUCTIONS FOR o_{14} LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
794	+0.0138	0.7	+0.435	−163	+0.0005	+0″.01
807	+ .0149	0.9	+ .360	−158	− .0008	− .02
1166	+ .0108	1.0	− .788	− 79	+ .0005	+ .01
1188	+ .0135	0.8	− .831	− 74	− .0023	− .04
1189	+ .0108	0.9	− .831	− 74	+ .0004	+ .01
1227	+ .0094	0.8	− .875	− 68	+ .0016	+ .03
2038	+ .0102	1.0	+ .934	+144	+ .0002	.00
2039	+ .0080	0.9	+ .934	+144	+ .0024	+ .05
2060	+ .0116	0.7	+ .917	+151	− .0013	− .02
2218	+0.0109	1.0	+0.718	+180	−0.0013	−0.03

The normal equations are:

$$8.7c + 0.438\mu + 0.8623\pi = + 0.0983 \text{ mm.}$$
$$+ 14.8074\mu + 5.9528\pi = - 0.0088 \text{ mm.}$$
$$+ 5.4181\pi = + 0.0084 \text{ mm.}$$

from which:

$c = + 0.01124$ mm.

$\mu = - 0.00149$ mm. $= - 0''.0311$, or $- 0''.113$ per year.

$\pi = + 0.00140$ mm. $= + \mathbf{0''.029 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00101 \text{ mm.} = \pm 0''.021.$$

ζ 36 LEONIS ($10^h\ 11^m$; $+23°\ 54'$)

This star is of magnitude 3.65, of type F, and of small proper motion 0″.02 per year. No parallax value has been published except the spectroscopic result of Mt. Wilson ± 0″.014. The series of plates is the same as for 35 Leonis, Table I, with the exception there noted. The proper motion in right ascension from Boss is + 0″.022 per year, while the value from the McCormick photographs is + 0″.013 per year. The plates were measured by Mr. Mitchell.

COMPARISON STARS FOR ζ LEONIS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−59.3	+18.0	+0.133
2	.16	− 6.1	−26.0	.228
3	.13	+11.1	+11.2	.194
4	.16	+19.3	+34.4	.171
5	.30	+35.0	−37.6	+0.274
Parallax star	0.21	+ 5.7	− 5.8	

TABLE 2

REDUCTIONS FOR ζ 36 LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
752	−0.0249	0.7	+0.639	−320	−0.0016	−0″.03
753	− .0246	0.8	+ .639	−320	− .0019	− .04
1137	− .0256	0.9	− .592	−237	− .0010	− .02
1152	− .0289	0.9	− .664	−231	+ .0022	+ .04
1153	− .0268	0.8	− .664	−231	+ .0001	.00
1197	− .0271	0.9	− .749	−223	+ .0004	+ .01
1271	− .0282	0.7	− .899	−203	+ .0015	+ .03
2141	− .0259	0.8	+ .884	+ 16	.0000	.00
2142	− .0255	0.9	+ .884	+ 16	− .0004	− .01
2170	− .0245	0.8	+ .831	+ 25	− .0014	− .03
2171	− .0266	0.8	+ .831	+ 25	+ .0007	+ .01
2309	− .0270	0.8	+ .569	+ 51	+ .0011	+ .02
3457	− .0286	0.9	+ .913	+373	+ .0033	+ .06
3458	− .0226	0.9	+ .913	+373	− .0027	− .05
3459	− .0287	0.6	+ .913	+373	+ .0034	+ .05
3493	− .0253	0.6	+ .894	+379	.0000	.00
3851	− .0260	1.0	− .681	+501	+ .0006	+ .01
3852	− .0243	1.0	− .681	+501	− .0011	− .02
3862	− .0250	0.9	− .703	+503	− .0004	− .01
3863	−0.0237	0.9	−0.703	+503	−0.0017	−0.03

The normal equations are:

$$16.6c + 17.092\mu + 1.3813\pi = -0.4305 \text{ mm.}$$
$$+ 174.9497\mu + 1.4063\pi = -0.4169 \text{ mm.}$$
$$+ 9.7377\pi = -0.0337 \text{ mm.}$$

from which:

$c = -0.02612$ mm.
$\mu = +0.00017$ mm. $= +0''.0035$, or $+0''.013$ per year.
$\pi = +0.00022$ mm. $= \mathbf{+0''.005 \pm 0''.007.}$

Probable error of plate of unit weight

$$\pm 0.00107 \text{ mm.} = \pm 0''.022.$$

35 LEONIS ($10^h\ 11^m$; $+24°\ 0'$)

This star is of 5.91 magnitude, and of G type. It has a total proper motion of $0''.24$ per year. It is situated $320''$ distant from ζ 36 Leonis, and the same series of plates was utilized for the measures of both stars, with the exception of the first four plates in Table I below, which were used for the measurement of 35 Leonis only. Allegheny by photography finds the relative parallax $+0''.038 \pm 0''.007$, while Adams and Joy derive the absolute result $+0''.030$. The proper motion in right ascension from the photographs is $-0''.181$ per year, while the value given by Boss is $-0''.208$. Mr. Mitchell measured the series of plates.

TABLE 1

PLATES OF 35 LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
2	1914 May 6	+1h1	M	1.0
3	May 9	+0.8	M	1.0
4	May 9	+1.4	M	0.6*
688	Dec. 17	−0.4	M	0.8
752	1915 Jan. 7	−1.2	M	0.7
753	Jan. 7	−0.7	M	0.8
1137	Mar. 31	+0.4	G	0.9
1152	Apr. 6	+0.3	M	0.9
1153	Apr. 6	+0.8	M	0.8
1197	Apr. 14	−0.2	G	0.9
1271	May 4	+0.6	M	0.7
2141	Dec. 9	−0.6	A	0.8
2142	Dec. 9	−0.1	A	0.9
2170	Dec. 18	−0.3	M	0.8
2171	Dec. 18	+0.1	M	0.8
2309	1916 Jan. 13	−0.9	M	0.8
3457	Nov. 30	−0.5	M	0.9
3458	Nov. 30	−0.2	M	0.9
3459	Nov. 30	+0.2	M	0.6*
3493	Dec. 6	−0.8	A	0.6*
3851	1917 Apr. 7	+0.1	A	1.0
3852	Apr. 7	+0.4	A	1.0
3862	Apr. 9	0.0	A	0.7
3863	Apr. 9	+0.1	A	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−60.8	+11.4	+0.255
3	.13	+ 9.6	+ 4.7	.255
4	.16	+17.7	+27.9	.276
5	.30	+33.5	−44.0	+0.214
Parallax star	0.09	− 1.0	+ 2.4	

TABLE 2

REDUCTIONS FOR 35 LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
2	−0.0018	1.0	−0.912	−566	−0.0007	−0″.01
3	+ .0002	1.0	− .922	−563	− .0027	− .06
4	− .0039	0.6	− .922	−563	+ .0014	+ .02
688	− .0074	0.8	+ .836	−341	.0000	.00
752	− .0104	0.7	+ .639	−320	+ .0024	+ .04
753	− .0074	0.8	+ .639	−320	− .0006	− .01
1137	− .0124	0.9	− .592	−237	+ .0022	+ .04
1152	− .0098	0.9	− .664	−231	− .0006	− .01
1153	− .0098	0.8	− .664	−231	− .0006	− .01
1197	− .0128	0.9	− .749	−223	+ .0022	+ .04
1271	− .0118	0.7	− .899	−203	+ .0007	+ .01
2141	− .0173	0.8	+ .884	+ 16	+ .0014	+ .03
2142	− .0126	0.9	+ .884	+ 16	− .0033	− .06
2170	− .0190	0.8	+ .831	+ 25	+ .0029	+ .05
2171	− .0142	0.8	+ .831	+ 25	− .0019	− .04
2309	− .0156	0.8	+ .569	+ 51	− .0012	− .02
3457	− .0244	0.9	+ .913	+373	.0000	.00
3458	− .0248	0.9	+ .913	+373	+ .0004	+ .01
3459	− .0212	0.6	+ .913	+373	− .0032	− .05
3493	− .0278	0.6	+ .894	+379	+ .0033	+ .05
3851	− .0272	1.0	− .681	+501	− .0006	− .01
3852	− .0272	1.0	− .681	+501	− .0006	− .01
3862	− .0311	0.7	− .703	+503	+ .0033	+ .06
3863	−0.0252	0.7	−0.703	+503	−0.0026	−0.05

The normal equations are:

$$19.6c - 2.316\mu - 0.0559\pi = -0.3024 \text{ mm.}$$
$$+ 256.8824\mu + 14.0075\pi = -0.5716 \text{ mm.}$$
$$+ 12.2910\pi = -0.0297 \text{ mm.}$$

from which:

$c = -0.01571$ mm.

$\mu = -0.00238$ mm. $= -0''.0495$, or $-0''.181$ per year.

$\pi = +0.00023$ mm. $= +\mathbf{0''.005 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00124 \text{ mm.} = \pm 0''.026.$$

40 LEONIS ($10^h\ 14^m$; $+19°\ 58'$)

This is a star with a total proper motion of 0″.34 per year. It is of F5 type, and of magnitude 4.97. The spectroscopic parallax of Adams and Joy is +0″.058. The proper motion in right ascension from the photographs is − 0″.218 per year while the value from Boss is − 0″.234. The plates were measured by Mr. Olivier.

TABLE 1

PLATES OF 40 LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
811	1915 Jan. 20	+0^h.5	G	0.8
827	Jan. 28	0.0	M	0.7
2124	Dec. 6	−0.1	Ol	0.6*
2125	Dec. 6	+0.5	Ol	0.6
2275	1916 Jan. 3	−0.8	Ol	0.9
2276	Jan. 3	−0.3	Ol	0.9
2331	Jan. 17	−0.3	Ol	0.6*
2332	Jan. 17	+0.2	Ol	0.7
2527	Mar. 30	−0.1	Ol	0.8
2528	Mar. 30	+0.5	Ol	0.8
2541	Mar. 31	0.0	G	0.7
2638	May 3	+0.6	Ol	0.8
3514	Dec. 9	−0.8	Ol	0.9
3515	Dec. 9	0.0	Ol	0.9
3573	1917 Jan. 11	−0.8	Ol	0.8
3574	Jan. 11	−0.2	Ol	0.6*
3740	Mar. 9	+0.2	Ol	0.9
3741	Mar. 9	+0.8	Ol	0.9
3831	Mar. 30	+0.4	Ol	0.8
3892	Apr. 18	+0.3	Ol	0.9
3954	May 14	+1.1	M	0.9
3967	May 15	+1.1	M	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.23	−65.5	+39.4	+0.2544
2	.14	+11.1	−32.4	.3053
3	.17	+14.3	−15.6	.2643
4	.37	+40.1	+ 8.6	+0.1760
Parallax star	0.20	− 2.4	− 2.5	

TABLE 2

REDUCTIONS FOR 40 LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
811	+0.0202	0.8	+0.481	−524	+0.0006	+0″.01
827	+ .0230	0.7	+ .367	−516	− .0027	− .05
2124	+ .0150	0.6	+ .899	−204	− .0024	− .04
2125	+ .0103	0.6	+ .899	−204	+ .0023	+ .04
2275	+ .0117	0.9	+ .706	−177	− .0004	− .01
2276	+ .0116	0.9	+ .706	−177	− .0002	.00
2331	+ .0100	0.6	+ .526	−162	+ .0005	+ .01
2332	+ .0142	0.7	+ .526	−162	− .0037	− .06
2527	+ .0051	0.8	− .578	− 89	+ .0008	+ .01
2528	+ .0033	0.8	− .578	− 89	+ .0026	+ .05
2541	+ .0015	0.7	− .590	− 88	+ .0044	+ .08
2638	+ .0047	0.8	− .888	− 56	− .0004	− .01
3514	+ .0015	0.9	+ .883	+165	+ .0004	+ .01
3515	+ .0006	0.9	+ .883	+165	+ .0013	+ .02
3573	+ .0007	0.8	+ .594	+198	− .0004	− .01
3574	− .0026	0.6	+ .594	+198	+ .0029	+ .05
3740	− .0027	0.9	− .274	+255	− .0006	− .01
3741	− .0026	0.9	− .274	+255	− .0007	− .01
3831	− .0053	0.8	− .574	+276	+ .0007	+ .01
3892	− .0027	0.9	− .783	+295	− .0029	− .06
3954	− .0060	0.9	− .935	+321	− .0007	− .01
3967	−0.0061	0.7	−0.937	+322	−0.0006	−0.01

The normal equations are:

$$17.2c + 2.306\mu + 0.8934\pi = + 0.0757 \text{ mm.}$$
$$+ 109.2606\mu - 12.4635\pi = - 0.3317 \text{ mm.}$$
$$+ 8.1644\pi = + 0.0584 \text{ mm.}$$

from which:

$c = + 0.00467$ mm.

$\mu = - 0.00288$ mm. $= - 0''.0598$, or $- 0''.218$ per year.

$\pi = + 0.00226$ mm. $= + \mathbf{0''.047 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00117 \text{ mm.} = \pm 0''.024.$$

γ LEONIS ($10^h\ 14^m$; $+20°\ 20'$)

The components of this well-known double, Σ 1424, are each of K type, and of magnitudes 2.61 and 3.80 respectively. According to Burnham, their relative motion is best explained by their having a slight difference in proper motion, and thus resembling the system of 61 Cygni. The proper motion for each is approximately $0''.34$ per year. Two measured parallaxes have been published, a value due to Flint with the meridian circle of $+ 0''.105 \pm 0''.040$, and a determination with the Yale heliometer by Smith with the very different value of $- 0''.046 \pm 0''.013$. Assuming the correctness of Doberck's orbit with a period of 402.62 years, Belopolsky from measures of radial velocity, which give a difference for the two components of 2.2 km. (*Astronomische Nachrichten*, **147**, 93, 1898), derives a parallax between $0''.015$ and $0''.025$. The Lick Observatory observations have a difference of only 0.1 km. for the two components (*Lick Observatory Bulletin*, **6**, 25, 1910). Adams and Joy find the absolute parallaxes $+ 0''.032$ and $+ 0''.026$ for brighter and fainter star, respectively.

On account of the fact that these stars are so bright, and that they are separated by only $3''.5$, it was very difficult to obtain a satisfactory series of photographs for measurement. The plates were measured by Mr. Mitchell. The weighted mean of the values of the two components gives the parallax of the system:

$$\mathbf{- 0''.007 \pm 0''.009}.$$

TABLE 1

PLATES OF γ LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
1208	1915 Apr. 15	0h0	Ol	1.0
1209	Apr. 15	+0.5	Ol	0.8
1241	Apr. 24	−0.5	A	0.9
1242	Apr. 24	+0.1	A	0.7
1251	Apr. 25	−0.2	M	0.9
1252	Apr. 25	+0.3	M	0.7
2191	Dec. 21	−0.8	M	0.7
2192	Dec. 21	−0.5	M	0.5*
2193	Dec. 21	0.0	M	0.8
2299	1916 Jan. 8	−0.4	M	0.4*
2334	Jan. 18	−0.8	M	0.8
2334	Jan. 18	−0.4	M	0.8
2557	Apr. 6	−0.3	M	0.8
2642	May 7	+0.6	M	0.8
2643	May 7	+1.0	M	0.7
2644	May 7	+1.5	M	0.7
2653	May 9	+0.6	M	1.0
3504	Dec. 7	−1.1	M	0.9
3505	Dec. 7	−0.7	M	0.8
3506	Dec. 7	−0.2	M	0.7
3507	Dec. 7	+0.2	M	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−64.7	−17.2	+0.138
2	.15	− 8.4	+14.1	.210
3	.19	− 6.3	+ 9.9	.207
4	.13	+38.4	+40.4	.271
5	.28	+41.0	−47.2	+0.174
Principal star	.22	+ 5.5	+ 5.3	
Companion	0.14	+ 5.5	+ 5.3	

TABLE 2

REDUCTIONS FOR γ LEONIS—PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1208	−0.1224	1.0	−0.750	−297	+0.0010	+0″.02
1209	− .1229	0.8	− .750	−297	+ .0015	+ .03
1241	− .1216	0.9	− .829	−288	+ .0007	+ .01
1242	− .1177	0.7	− .829	−288	− .0032	− .06
1251	− .1198	0.9	− .836	−287	− .0011	− .02
1252	− .1170	0.7	− .836	−287	− .0039	− .07
2191	− .1090	0.7	+ .814	− 47	− .0001	.00
2192	− .1110	0.5	+ .814	− 47	+ .0019	+ .03
2193	− .1115	0.8	+ .814	− 47	+ .0024	+ .04
2299	− .1065	0.4	+ .640	− 29	− .0017	− .02
2334	− .1101	0.8	+ .514	− 19	+ .0024	+ .04
2335	− .1075	0.8	+ .514	− 19	− .0002	.00
2557	− .1022	0.8	− .662	+ 60	− .0015	− .03
2642	− .1034	0.8	− .912	+ 91	+ .0013	+ .02
2643	− .1041	0.7	− .912	+ 91	+ .0020	+ .03
2644	− .1026	0.7	− .912	+ 91	+ .0005	+ .01
2653	− .1030	1.0	− .920	+ 93	+ .0010	+ .02
3504	− .0916	0.9	+ .892	+305	− .0001	.00
3505	− .0884	0.8	+ .892	+305	− .0033	− .06
3506	− .0900	0.7	+ .892	+305	− .0017	− .03
3507	−0.0925	0.8	+ .892	+305	+0.0008	+0.01

The normal equations are:

$$16.2c - 2.734\mu - 1.9092\pi = -1.7423 \text{ mm.}$$
$$+ 75.6036\mu + 16.3795\pi = +0.6650 \text{ mm.}$$
$$+ 10.7150\pi = +0.2840 \text{ mm.}$$

from which:

$c = -0.10672$ mm.

$\mu = +0.00496$ mm. $= +0''.1031$, or $+0''.376$ per year.

$\pi = -0.00009$ mm. $= -\mathbf{0''.002 \pm 0''.009}$.

Probable error of plate of unit weight

$$= \pm 0.00043 \text{ mm.} = \pm 0''.009.$$

TABLE 2

REDUCTIONS FOR γ LEONIS—COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1208	+0.0371	1.0	−0.750	−297	0.0000	0″.00
1209	+ .0383	0.8	− .750	−297	− .0012	− .02
1241	+ .0432	0.9	− .829	−288	− .0056	− .11
1242	+ .0398	0.7	− .829	−288	− .0022	− .04
1251	+ .0371	0.9	− .836	−287	+ .0006	+ .01
1252	+ .0384	0.7	− .836	−287	− .0007	− .01
2191	+ .0474	0.7	+ .814	− 47	+ .0008	+ .01
2192	+ .0450	0.5	+ .814	− 47	+ .0032	+ .05
2193	+ .0452	0.8	+ .814	− 47	+ .0030	+ .06
2334	+ .0472	0.8	+ .514	− 19	+ .0027	+ .05
2335	+ .0466	0.8	+ .514	− 19	+ .0033	+ .06
2642	+ .0564	0.8	− .912	+ 91	+ .0006	+ .01
2643	+ .0568	0.7	− .912	+ 91	+ .0002	.00
2644	+ .0558	0.7	− .912	+ 91	+ .0012	+ .02
2653	+ .0526	1.0	− .920	+ 93	+ .0045	+ .09
3504	+ .0676	0.9	+ .892	+305	− .0016	− .03
3505	+ .0701	0.8	+ .892	+305	− .0041	− .08
3506	+ .0650	0.7	+ .892	+305	+ .0010	+ .02
3507	+0.0706	0.8	+0.892	+305	−0.0046	−0.09

The normal equations are:

$$15.0c - 3.098\mu - 1.6356\pi = +0.7571 \text{ mm.}$$
$$+ 75.2820\mu + 16.7715\pi = + 0.2056 \text{ mm.}$$
$$+ 10.2006\pi = - 0.0094 \text{ mm.}$$

from which:

$c = + 0.05141$ mm.

$\mu = + 0.00507$ mm. $= + 0''.1055$, or $+ 0''.385$ per year.

$\pi = - 0.00101$ mm. $= - \mathbf{0''.021 \pm 0''.015}$.

Probable error of plate of unit weight

$$\pm 0.00072 \text{ mm.} = \pm 0''.015.$$

β LEONIS MINORIS ($10^h\ 22^m$; $+37°\ 13'$)

Although of small total proper motion $0''.164$, Abetti by meridian circle has found a rather large parallax for this star amounting to $+ 0''.230 \pm 0''.043$, the star being of magnitude 4.41 and type K. Adams and Joy find the spectroscopic value $+ 0''.020$. Thirteen of the McCormick plates were measured by Mr. Alden, the remaining eight by Mr. Mitchell. A relative parallax of $+ 0''.008 \pm 0''.009$ was found, and a proper motion in right ascension of $- 0''.128$ while the corresponding value from Boss is $- 0''.122$.

TABLE 1

PLATES OF β LEONIS MINORIS

No.	Date.	Hour Angle.	Observers.	Weight.
2291	1916 Jan. 7	$-0^h.2$	Ol	0.4*
2351	Jan. 23	−0.6	G	0.4
2367	Feb. 3	−0.3	A	0.8
2582	Apr. 20	−0.3	G	0.6
2590	Apr. 24	−0.5	M	0.6
2591	Apr. 24	−0.2	M	0.6
4808	1917 Nov. 22	−0.8	B	1.0
4809	Nov. 22	−0.3	B	1.0
4932	1918 Jan. 13	−0.5	Ol	0.6*
5026	Feb. 7	−0.1	Ol	0.6*
5294	Apr. 15	−0.4	A	1.0
5344	May 2	0.0	A	1.0
5354	May 5	0.0	A	0.7*
6181	1919 Jan. 6	−1.2	F	0.8
6349	Jan. 26	−0.9	H	1.0
6350	Jan. 26	−0.3	H	0.8
6391	Jan. 29	−0.7	M	0.8
6770	Mar. 28	−0.7	F	0.6
6917	Apr. 21	−0.5	F	0.9
6927	Apr. 23	−0.2	Ol	0.7*
6936	Apr. 25	−0.4	F	1.0†

* One exposure. † Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−62.4	+21.3	+0.2616
2	.20	−26.5	−44.6	.1828
3	.16	+31.4	+15.0	.2787
4	.14	+57.5	+ 8.3	+0.2769
Parallax star	0.18	+ 3.5	+ 3.9	

TABLE 2

REDUCTIONS FOR β LEONIS MINORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2291	−0.0218	0.4	+0.672	−713	+0.0020	+0″.03
2351	− .0208	0.4	+ .472	−697	+ .0007	+ .01
2367	− .0218	0.8	+ .311	−686	+ .0014	+ .03
2582	− .0267	0.6	− .783	−609	+ .0046	+ .07
2590	− .0190	0.6	− .817	−605	− .0032	− .05
2591	− .0202	0.6	− .817	−605	− .0020	− .03
4808	− .0306	1.0	+ .918	− 28	− .0007	− .01
4809	− .0308	1.0	+ .918	− 28	− .0005	− .01
4932	− .0340	0.6	+ .596	+ 24	+ .0017	+ .03
5026	− .0285	0.6	+ .241	+ 49	− .0044	− .07
5294	− .0337	1.0	− .730	+116	− .0006	− .01
5344	− .0341	1.0	− .871	+133	− .0006	− .01
5354	− .0325	0.7	− .888	+136	− .0022	− .04
6181	− .0351	0.8	+ .680	+382	− .0032	− .06
6349	− .0402	1.0	+ .426	+402	+ .0014	+ .03
6350	− .0407	0.8	+ .426	+402	+ .0019	+ .04
6391	− .0390	0.8	+ .382	+405	+ .0002	.00
6770	− .0414	0.6	− .513	+463	+ .0012	+ .02
6917	− .0422	0.9	− .785	+487	+ .0016	+ .03
6927	− .0400	0.7	− .802	+489	− .0007	− .01
6936	−0.0422	1.0	−0.818	+491	+0.0015	+0.03

The normal equations are:

$$15.9c + 10.304\mu - 1.4055\pi = -0.5285 \text{ mm.}$$
$$+ 277.2739\mu - 4.5839\pi = -0.8020 \text{ mm.}$$
$$+ 7.9381\pi = +0.0559 \text{ mm.}$$

from which:

$c = -0.03211$ mm.
$\mu = -0.00169$ mm. $= -0''.0352$, or $-0''.128$ per year.
$\pi = +0.00038$ mm. $= +0''.008 \pm 0''.009$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

46 LEONIS MINORIS ($10^h\ 47^m$; $+34°\ 45'$)

This is a Ko type star, of magnitude 3.92, and of total annual proper motion $0''.304$. Its parallax has been twice determined, the relative value from the meridian circle by Abetti gives the result $+0''.085 \pm 0''.049$, and the absolute value by Adams' spectroscopic method is $+0''.019$. Twenty of the McCormick plates were measured by Mr. Mitchell, the balance by Mr. Lamb. The photographic proper motion in right ascension was found to be $+0''.076$ while the corresponding value from Boss is $+0''.091$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−53.9	− 0.7	+0.174
2	.14	−20.2	+24.3	.554
3	.12	+74.1	−23.6	+0.272
Parallax star	0.15	− 0.5	+ 6.9	

TABLE 1

PLATES OF 46 LEO MINORIS

No.	Date.	Hour Angle.	Observers.	Weight.
795	1915 Jan. 14	−1h0	M	0.8
1260	Apr. 30	−0.6	G	0.4*
1261	Apr. 30	−0.2	G	0.7
2154	Dec. 10	−0.6	G	0.5
2241	Dec. 29	−1.2	G	0.8
2242	Dec. 29	−0.9	G	0.7
2257	1916 Jan. 2	−1.2	G	0.7
2258	Jan. 2	−0.7	G	0.7
2569	Apr. 17	−0.6	G	0.7
2612	Apr. 29	−0.6	A	0.8
2613	Apr. 29	−0.3	A	0.8
2623	May 1	−0.6	G	0.5
2624	May 1	−0.2	G	0.5
3533	Dec. 17	−0.6	L	0.8
3534	Dec. 17	−0.3	L	0.8
3571	1917 Jan. 9	−1.4	L	0.9
3572	Jan. 9	−1.0	L	0.9
3933	May 2	−0.5	Ol	0.9
3934	May 2	−0.2	Ol	1.0
3935	May 2	−0.2	M	0.8
4833	Dec. 1	−0.2	B	0.8
4834	Dec. 1	−1.0	B	0.8
5280	1918 Apr. 14	−0.2	M	0.8
5332	May 1	−0.5	Ol	0.8
5333	May 1	−0.2	Ol	0.6
5345	May 2	0.0	A	1.2†
6042	Nov. 30	−0.6	M	0.7
6043	Nov. 30	−0.3	M	0.7
6057	Dec. 2	−0.2	H	0.9
6095	Dec. 17	−0.3	D	0.9
6162	Dec. 29	−0.5	M	1.0
6163	Dec. 29	−0.2	M	1.0

* One exposure. † Three exposures.

TABLE 2

REDUCTIONS FOR 46 LEO MINORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
795	−0.0544	0.8	+0.662	−786	+0.0022	+0″.04
1260	− .0593	0.4	− .798	−680	+ .0048	+ .06
1261	− .0579	0.7	− .798	−680	+ .0034	+ .06
2154	− .0497	0.5	+ .903	−456	+ .0013	+ .02
2241	− .0506	0.8	+ .812	−437	+ .0022	+ .04
2242	− .0449	0.7	+ .812	−437	− .0035	− .06
2257	− .0490	0.7	+ .781	−433	+ .0006	+ .01
2258	− .0489	0.7	+ .781	−433	+ .0005	+ .01
2569	− .0472	0.7	− .680	−327	− .0035	− .06
2612	− .0488	0.8	− .796	−315	− .0020	− .04
2613	− .0508	0.8	− .796	−315	.0000	.00
2623	− .0450	0.5	− .813	−313	− .0058	− .09
2624	− .0470	0.5	− .813	−313	− .0038	− .06
3533	− .0495	0.8	+ .877	− 83	+ .0048	+ .09
3534	− .0449	0.8	+ .877	− 83	+ .0002	.00
3571	− .0398	0.9	+ .709	− 60	− .0050	− .10
3572	− .0414	0.9	+ .709	− 60	− .0034	− .07
3933	− .0466	0.9	− .819	+ 53	− .0006	− .01
3934	− .0486	1.0	− .819	+ 53	+ .0014	+ .03
3935	− .0469	0.8	− .819	+ 53	− .0003	.00
4833	− .0398	0.8	+ .912	+266	− .0013	− .02
4834	− .0444	0.8	+ .912	+266	+ .0033	+ .06
5280	− .0471	0.8	− .640	+400	+ .0038	+ .07
5332	− .0419	0.8	− .809	+417	− .0016	− .03
5333	− .0476	0.6	− .809	+417	+ .0041	+ .07
5345	− .0436	1.2	− .817	+418	+ .0001	.00
6042	− .0334	0.7	+ .912	+630	− .0040	− .07
6043	− .0332	0.7	+ .912	+630	− .0042	− .07
6057	− .0370	0.9	+ .912	+632	− .0004	− .01
6095	− .0406	0.9	+ .880	+647	+ .0033	+ .06
6162	− .0379	1.0	+ .810	+659	+ .0005	+ .01
6163	−0.0391	1.0	+0.810	+659	+0.0017	+0.04

The normal equations are:

$$24.9c + 11.720\mu + 3.6640\pi = -1.1213 \text{ mm.}$$
$$+ 486.7224\mu + 16.7449\pi = -0.0105 \text{ mm.}$$
$$+ 16.5446\pi = -0.1135 \text{ mm.}$$

from which:

$c = -0.04584$ mm.

$\mu = +0.00100$ mm. $= +0''.0209$, or $+0''.076$ per year.

$\pi = +0.00227$ mm. $= +\mathbf{0''.047 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00175 \text{ mm.} = \pm 0''.036.$$

χ LEONIS ($11^h\ 0^m$; $+7°\ 53'$)

This star has a total proper motion of $0''.35$, it is magnitude 4.66, and of type F. Adams has found the parallax from

TABLE 1

PLATES OF χ LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
669	1914 Dec. 14	$-0^h.8$	M	1.0
670	Dec. 14	−0.3	M	0.9
682	Dec. 16	−0.3	G	0.8
724	Dec. 27	−1.0	G	0.4
1190	1915 Apr. 13	+0.3	M	1.0
1191	Apr. 13	+0.8	M	0.9
1305	May 13	+0.8	Ol	0.9
2143	Dec. 9	−0.9	A	0.7*
2144	Dec. 9	−0.4	A	0.7*
2277	1916 Jan. 3	−0.3	Ol	1.0
2278	Jan. 3	+0.2	Ol	0.9
2333	Jan. 17	+0.2	Ol	0.9
2558	Apr. 6	−0.3	M	0.8
2559	Apr. 6	+0.2	M	0.9
2566	Apr. 15	−0.9	Ol	0.6*
2604	Apr. 27	+0.5	Ol	0.9
2605	Apr. 27	+1.2	Ol	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−22.8	−27.5	+0.3208
2	.10	−19.0	+26.9	.4240
3	.16	+41.8	+ 0.6	+0.2552
Parallax star	0.15	− 4.7	+ 2.7	

TABLE 2

REDUCTIONS FOR χ LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
669	+0.0098	1.0	+0.898	−279	+0.0006	+0″.01
670	+ .0058	0.9	+ .898	−279	+ .0046	+ .09
682	+ .0125	0.8	+ .892	−277	− .0022	− .04
724	+ .0109	0.4	+ .842	−266	− .0010	− .01
1190	+ .0072	1.0	− .585	−159	− .0021	− .04
1191	+ .0053	0.9	− .585	−159	− .0002	.00
1305	+ .0042	0.9	− .867	−129	− .0003	− .01
2143	− .0011	0.7	+ .907	+ 81	− .0028	− .05
2144	− .0019	0.7	+ .907	+ 81	− .0020	− .03
2277	− .0060	1.0	+ .797	+106	+ .0010	+ .02
2278	− .0035	0.9	+ .797	+106	− .0014	− .03
2333	− .0066	0.9	+ .663	+120	+ .0010	+ .02
2558	− .0094	0.8	− .505	+200	+ .0003	.00
2559	− .0131	0.9	− .505	+200	+ .0040	+ .08
2566	− .0076	0.6	− .618	+209	− .0019	− .03
2604	− .0090	0.9	− .748	+221	− .0010	− .02
2605	−0.0111	0.8	−0.748	+221	+0.0011	+0.02

spectroscopic measures to be + 0″.009. There is no other published parallax. Mr. Olivier measured the series of plates, and determined the proper motion in right ascension to be − 0″.302 while the value from Boss is − 0″.345.

The normal equations are:

$$14.1c - 0.124\mu + 1.7447\pi = - 0.0129 \text{ mm.}$$
$$+ 52.1326\mu - 6.8115\pi = - 0.2093 \text{ mm.}$$
$$+ 8.1471\pi = + 0.0279 \text{ mm.}$$

from which:

$c = - 0.00099$ mm.
$\mu = - 0.00398$ mm. $= - 0''.0827$, or $- 0''.302$ per year.
$\pi = + 0.00032$ mm. $= + \mathbf{0''.007 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00138 \text{ mm.} = \pm 0''.029.$$

LALANDE 21258 ($11^h\ 0^m$; $+44°\ 2'$)

This star of 8.9 magnitude, and of Ma type has a very large proper motion of 4″.47 per year. It has many times been investigated for parallax and with the following results:

Parallax.	Authority.	Method.
+0″.262±0″.011	Auwers	Heliometer
.260± .020	Krueger	Heliometer
.37 ± .110	Flint	Meridian Circle
.168± .027	Kapteyn	Meridian Circle
.163± .018	Russell	Photography
+0.202	Adams	Spectrograph

Mr. Mitchell measured the McCormick plates and derived the proper motion in right ascension of − 4″.398, while the value of Boss is − 4″.334.

TABLE 1

PLATES OF LALANDE 21258

No.	Date.	Hour Angle.	Observers.	Weight.
689	1914 Dec. 17	−0h2	M	0.5*
770	1915 Jan. 9	−0.1	M	1.0
881	Feb. 10	−0.2	M	1.0
1273	May 8	−0.1	A	1.0
1283	May 9	−0.1	M	1.0
1296	May 10	−0.2	Ol	0.7
2160	Dec. 14	−0.8	M	1.0
2161	Dec. 14	−0.5	M	1.0
2300	1916 Jan. 8	−0.5	M	0.9
2310	Jan. 13	−0.9	M	1.0
3508	Dec. 7	−0.1	M	0.8
3524	Dec. 12	−0.8	M	0.7
3525	Dec. 12	−0.4	M	1.0
3613	1917 Jan. 25	−0.4	M	1.0
3914	Apr. 23	−0.2	A	1.0
3917	Apr. 26	−0.1	A	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−67.5	− 6.8	+0.218
2	.12	−14.3	+ 3.9	.201
3	.12	+ 5.8	+45.0	.177
4	.18	+22.8	−56.5	.222
5	.15	+53.2	+14.4	+0.182
Parallax star	0.19	− 1.9	− 2.6	

TABLE 2

REDUCTIONS FOR LALANDE 21258

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
689	−0.0658	0.5	+0.890	−396	−0.0046	−0″.07
770	− .0858	1.0	+ .745	−373	+ .0008	+ .02
881	− .1085	1.0	+ .352	−341	+ .0017	+ .04
1273	− .1664	1.0	− .831	−254	− .0009	− .02
1283	− .1662	1.0	− .838	−253	− .0017	− .04
1296	− .1672	0.7	− .845	−252	− .0014	− .02
2160	− .2811	1.0	+ .899	− 34	+ .0011	+ .02
2161	− .2824	1.0	+ .899	− 34	+ .0024	+ .05
2300	− .2985	0.9	+ .756	− 9	+ .0028	+ .05
2310	− .3001	1.0	+ .709	− 4	+ .0011	+ .02
3508	− .4838	0.8	+ .908	+325	− .0041	− .08
3524	− .4861	0.7	+ .902	+330	− .0048	− .08
3525	− .4909	1.0	+ .902	+330	.0000	.00
3613	− .5194	1.0	+ .564	+374	+ .0002	.00
3914	− .5809	1.0	− .701	+462	− .0001	.00
3917	−0.5866	0.8	−0.732	+465	+0.0036	+0.07

The normal equations are:

$$14.4c + 3.535\mu + 4.0061\pi = -4.5969 \text{ mm.}$$
$$+ 130.5127\mu + 2.8479\pi = -8.6230 \text{ mm.}$$
$$+ 8.8819\pi = -1.3208 \text{ mm.}$$

from which:

$c = -0.30737$ mm.

$\mu = -0.05793$ mm. $= -1''.2050$, or $-4''.398$ per year.

$\pi = +0.00851$ mm. $= +\mathbf{0''.177 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00161 \text{ mm.} = \pm 0''.033.$$

LALANDE 21565 ($11^h\ 13^m$; $-4°\ 31'$)

This star of total proper motion $0''.81$ is of magnitude 7.2 and of K type. Chase with the Yale heliometer determined the

relative parallax $0''.000 \pm 0''.021$, while Mt. Wilson with the spectrograph derived the absolute value $+ 0''.069$. Miss Darkow measured the McCormick plates except four measured by Mr. Mitchell, and derived a parallax $+ 0''.043 \pm 0''.012$ with a proper motion in right ascension $+ 0''.818$ per year where the corresponding value from Boss is $+ 0''.795$.

TABLE 1

PLATES OF LALANDE 21565

No.	Date.	Hour Angle.	Observers.	Weight.
4898	1917 Dec. 22	$+0^h.2$	B	1.0
5376	1918 May 17	+0.3	Ol	1.0
5377	May 17	+0.7	Ol	1.0
6096	Dec. 17	+0.2	D	0.8
6097	Dec. 17	+0.7	D	0.7
6313	1919 Jan. 21	−1.1	F	1.0
6314	Jan. 21	−0.8	F	1.0
6828	Apr. 5	+0.1	F	0.8
6869	Apr. 12	+0.7	H	0.9
6870	Apr. 12	+1.0	H	0.9
6988	May 12	0.0	D	1.0
6989	May 12	+0.4	D	0.9
8315	Dec. 20	−0.7	F	1.0
8316	Dec. 20	−0.2	F	1.0
8413	1920 Jan. 5	−0.6	F	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−78.5	+ 9.2	+0.242
2	.13	− 2.6	−24.2	.283
3	.08	+29.0	+28.8	.209
4	.10	+52.1	−13.8	+0.266
Parallax star	0.14	+ 0.2	− 2.3	

TABLE 2

REDUCTIONS FOR LALANDE 21565

Plate.	Solution $\gamma(m)$.	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4898	+0.0011	1.0	+0.881	−429	−0.0014	−0″.03
5376	+ .0098	1.0	− .868	−283	+ .0020	+ .04
5377	+ .0110	1.0	− .868	−283	+ .0008	+ .02
6096	+ .0352	0.8	+ .897	− 69	+ .0033	+ .06
6097	+ .0364	0.7	+ .897	− 69	+ .0021	+ .04
6313	+ .0430	1.0	+ .656	− 34	− .0012	− .02
6314	+ .0462	1.0	+ .656	− 34	− .0044	− .09
6828	+ .0487	0.8	− .429	+ 40	− .0012	− .02
6869	+ .0447	0.9	− .525	+ 47	+ .0034	+ .07
6870	+ .0468	0.9	− .525	+ 47	+ .0013	+ .02
6988	+ .0536	1.0	− .834	+ 77	− .0029	− .06
6989	+ .0529	0.9	− .834	+ 77	− .0022	− .04
8315	+ .0781	1.0	+ .889	+299	+ .0001	.00
8316	+ .0778	1.0	+ .889	+299	+ .0004	+ .01
8413	+0.0785	1.0	+0.805	+315	+0.0012	+0.02

The normal equations are:

$$14.0c + 0.094\mu + 1.5127\pi = + 0.6217 \text{ mm.}$$
$$+ 64.8221\mu + 5.8093\pi = + 0.7147 \text{ mm.}$$
$$+ 8.5442\pi = + 0.1470 \text{ mm.}$$

from which:

$c = + 0.04411$ mm.

$\mu = + 0.01078$ mm. $= + 0''.2242$, or $+ 0''.818$ per year.

$\pi = + 0.00207$ mm. $= + \mathbf{0''.043 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00159 \text{ mm.} = \pm 0''.033.$$

λ DRACONIS ($11^h\ 25^m$; $+69°\ 52'$)

This star, of magnitude 4.06, of type Ma, has a small proper motion of 0″.05 per year. The spectroscopic parallax of Adams

and Joy is + 0″.010. Mr. Olivier measured the series of plates, and determined the proper motion in right ascension − 0″.048 per year, while the corresponding value from Boss is − 0″.034.

TABLE 1

PLATES OF λ DRACONIS

No.	Date.	Hour Angle.	Observers.	Weight.
2336	1916 Jan. 18	−0ʰ6	M	0.7
2352	Jan. 23	−0.9	G	0.8
2353	Jan. 23	−0.5	G	0.7
2378	Feb. 7	−1.0	G	0.8
2379	Feb. 7	−0.5	G	0.9
2579	Apr. 19	−0.9	Ol	0.9
2640	May 5	−0.5	G	1.0
2641	May 5	−0.1	G	1.0
2655	May 12	−0.4	Ol	0.6
3573	1917 Jan. 9	−1.0	L	1.0
3574	Jan. 9	−0.6	L	1.0
3633	Jan. 29	−0.9	Ol	1.1*
3634	Jan. 29	−0.3	Ol	0.9
3945	May 10	−0.5	Ol	0.9
3946	May 10	0.0	Ol	0.9
3947	May 10	+0.4	Ol	0.9
3951	May 13	−0.2	M	0.8
3952	May 13	+0.1	M	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.07	−33.6	+34.2	+0.1797
2	.13	−23.0	−18.7	.3025
3	.08	−20.5	− 2.4	.2627
4	.16	+77.1	−13.1	+0.2551
Parallax star	0.17	+ 1.3	− 3.5	

TABLE 2

REDUCTIONS FOR λ DRACONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2336	+0.0011	0.7	+0.720	−241	+0.0005	+0″.01
2352	.0000	0.8	+ .669	−236	+ .0016	+ .03
2353	+ .0022	0.7	+ .669	−236	− .0006	− .01
2378	+ .0031	0.8	+ .490	−221	− .0018	− .03
2379	+ .0014	0.9	+ .490	−221	− .0001	.00
2579	− .0006	0.9	− .578	−149	+ .0008	+ .02
2640	+ .0010	1.0	− .753	−133	− .0010	− .02
2641	− .0010	1.0	− .753	−133	+ .0010	+ .02
2655	+ .0006	0.6	− .813	−126	− .0007	− .01
3573	− .0005	1.0	+ .793	+116	− .0001	.00
3574	+ .0005	1.0	+ .793	+116	− .0011	− .02
3633	− .0010	1.1	+ .595	+136	+ .0001	.00
3634	− .0023	0.9	+ .595	+136	+ .0014	+ .03
3945	− .0014	0.9	− .795	+237	− .0010	− .02
3946	− .0036	0.9	− .795	+237	+ .0012	+ .02
3947	− .0024	0.9	− .795	+237	.0000	.00
3951	− .0022	0.8	− .818	+240	− .0002	.00
3952	−0.0022	1.0	−0.818	+240	−0.0002	0.00

The normal equations are:

$$15.9c + 2.018\mu - 1.0164\pi = -0.0079 \text{ mm.}$$
$$+ 59.1355\mu - 7.1939\pi = -0.0430 \text{ mm.}$$
$$+ 8.1503\pi = +0.0101 \text{ mm.}$$

from which:

$c = -0.00038$ mm.

$\mu = -0.00064$ mm. $= -0''.0133$, or $-0''.048$ per year.

$\pi = +0.00063$ mm. $= +\mathbf{0''.013} \pm \mathbf{0''.005}$.

Probable error of plate of unit weight

$$\pm 0.00063 \text{ mm.} = \pm 0''.013.$$

93 LEONIS ($11^h\ 42^m$; $+20°\ 46'$)

This star is of magnitude 4.54, and of type F8. It has a proper motion of $0''.17$ which is common to an eighth magnitude star

at a distance of 75″. Campbell and Wright (*Astrophysical Journal*, **12**, 255, 1900) found 93 Leonis to be a spectroscopic binary. The only parallax published is that of Adams who finds the value + 0″.032. Mr. Graham measured the series of plates

TABLE 1

PLATES OF 93 LEONIS

No.	Date.	Hour Angle.	Observers.	Weight.
690	1914 Dec. 17	−0h1	M	1.0
691	Dec. 17	+0.4	M	0.7
703	Dec. 22	0.0	Ol	1.0
787	1915 Jan. 13	−0.8	G	0.7
898	Feb. 18	−0.6	G	0.7
1262	Apr. 30	−0.5	G	1.0
1314	May 14	−0.4	G	0.7
1317	May 16	+0.6	M	0.7
1320	May 21	+0.2	A	1.0
1331	June 4	+1.5	G	1.0
2156	Dec. 10	−0.6	G	0.7
2209	Dec. 22	−0.6	G	0.6
2210	Dec. 22	−0.1	G	0.7
2243	Dec. 29	−1.0	G	0.7
2244	Dec. 29	−0.5	G	1.0
3953	1917 May 13	+0.3	M	0.9
3955	May 14	+0.1	M	0.8
3972	May 18	+0.1	A	1.0
3979	May 19	+0.2	Ol	0.8

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−65.4	−10.1	+0.1982
2	.12	−13.7	−27.0	.2385
3	.09	+37.9	−14.8	.2796
4	.14	+41.2	+51.9	+0.2837
Parallax star	0.14	+ 6.0	+ 2.2	

with the exception of the last four plates which were measured by Mr. Mitchell. The proper motion in right ascension as determined from the photographs is $-0''.123$ per year, while the value from Boss is $-0''.156$.

TABLE 2

REDUCTIONS FOR 93 LEONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
690	−0.0087	1.0	+0.903	−370	0.0000	0″.00
691	− .0083	0.7	+ .903	−370	− .0004	− .01
703	− .0106	1.0	+ .899	−365	+ .0018	+ .04
787	− .0090	0.7	+ .801	−343	− .0002	.00
898	− .0134	0.7	+ .398	−307	+ .0031	+ .05
1262	− .0114	1.0	− .643	−236	− .0012	− .02
1314	− .0130	0.7	− .783	−222	.0000	.00
1317	− .0104	0.7	− .800	−220	− .0027	− .05
1320	− .0152	1.0	− .807	−219	+ .0021	+ .04
1331	− .0124	1.0	− .910	−201	− .0011	− .02
2156	− .0124	0.7	+ .896	− 12	− .0021	− .04
2209	− .0151	0.6	+ .900	0	+ .0004	+ .01
2210	− .0163	0.7	+ .900	0	+ .0016	+ .03
2243	− .0096	0.7	+ .883	+ 7	− .0052	− .09
2244	− .0155	1.0	+ .883	+ 7	+ .0007	+ .01
3953	− .0245	0.9	− .779	+508	− .0003	− .01
3955	− .0253	0.8	− .787	+509	+ .0005	+ .01
3972	− .0237	1.0	− .819	+513	− .0012	− .02
3979	−0.0282	0.8	−0.827	+514	+0.0032	+0.06

The normal equations are:

$$15.7c - 6.223\mu + 0.2923\pi = -0.2361 \text{ mm.}$$
$$+ 164.0953\mu - 18.5156\pi = -0.1890 \text{ mm.}$$
$$+ 10.7244\pi = +0.0378 \text{ mm.}$$

from which:

$c = -0.01570$ mm.

$\mu = -0.00162$ mm. $= -0''.0337$, or $-0''.123$ per year.

$\pi = +0.00116$ mm. $= +\mathbf{0''.024 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

β VIRGINIS ($11^h\ 45^m$; $+2°\ 20'$)

This star, of magnitude 3.80, and of type F8 has a considerable proper motion of 0″.79 per year. Its parallax has been determined by the Yale heliometer by Chase to be + 0″.11 ± 0″.047. The Allegheny result by photography is + 0″.096

TABLE 1

PLATES OF β VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
20	1914 May 17	+0^{h}1	M	0.6*
21	May 17	+0.8	M	0.6*
26	May 18	0.0	M	0.7
27	May 19	+0.2	M	0.7
671	Dec. 14	−0.2	M	0.8
683	Dec. 16	−0.2	G	0.8
725	Dec. 27	−1.0	G	0.7
1274	1915 May 8	−0.2	A	0.8
1286	May 9	+0.7	M	1.0
1338	June 5	+1.4	A	0.8
2175	Dec. 18	+0.5	M	0.8
2211	Dec. 22	+0.4	G	0.7
2292	1916 Jan. 7	−0.7	Ol	0.8
2293	Jan. 7	−0.3	Ol	0.8
3988	1917 May 21	+0.4	M	1.0
3989	May 23	+0.2	Ol	1.0
3990	May 23	+0.7	Ol	1.0
4008	May 25	+0.3	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−36.0	−32.4	+0.255
2	.14	−10.2	+61.2	.266
3	.20	+22.5	+ 3.9	.243
4	.12	+23.7	−32.7	+0.236
Parallax star	0.18	− 0.8	+ 1.3	

$\pm$ 0″.006. Adams by means of the spectroscope finds the value of + 0″.132. Mr. Mitchell measured the series of plates and determined the proper motion in right ascension of + 0″.744 per year, while the value from Boss is + 0″.750.

TABLE 2

REDUCTIONS FOR β VIRGINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
20	−0.0516	0.6	−0.804	−430	+0.0006	+0″.01
21	− .0502	0.6	− .804	−430	− .0008	− .01
26	− .0486	0.7	− .811	−429	− .0023	− .04
27	− .0486	0.7	− .819	−428	− .0023	− .04
671	− .0199	0.8	+ .901	−219	− .0024	− .05
683	− .0225	0.8	+ .903	−217	+ .0004	+ .01
725	− .0229	0.7	+ .890	−206	+ .0018	+ .03
1274	− .0166	0.8	− .720	− 74	+ .0011	+ .02
1286	− .0170	1.0	− .731	− 73	+ .0016	+ .03
1338	− .0172	0.8	− .911	− 46	+ .0037	+ .07
2175	+ .0128	0.8	+ .903	+150	+ .0013	+ .02
2211	+ .0124	0.7	+ .900	+154	+ .0021	+ .04
2292	+ .0178	0.8	+ .846	+170	− .0020	− .04
2293	+ .0167	0.8	+ .846	+170	− .0009	− .02
3988	+ .0590	1.0	− .836	+670	− .0016	− .03
3989	+ .0586	1.0	− .849	+672	− .0010	− .02
3990	+ .0592	1.0	− .849	+672	− .0016	− .03
4008	+0.0554	1.0	−0.862	+674	+0.0023	+0.05

The normal equations are:

$$14.6c + 14.099\mu - 2.7654\pi = + 0.0553 \text{ mm.}$$
$$+ 248.3270\mu - 12.5633\pi = + 2.3252 \text{ mm.}$$
$$+ 10.4229\pi = - 0.0627 \text{ mm.}$$

from which:

$c = - 0.00487$ mm.

$\mu = + 0.00987$ mm. $= + 0″.2056$, or + 0″.751 per year.

$\pi = + 0.00459$ mm. $= + \mathbf{0″.096 \pm 0″.008}$.

Probable error of plate of unit weight

$$\pm 0.00122 \text{ mm.} = \pm 0″.025.$$

GROOMBRIDGE 1830 ($11^h\ 47^m$; $+38°\ 26'$)

Only two star are known to have a proper motion greater than Groombridge 1830. These are Cordoba Z. 5^h243 with an annual proper motion of $8''.7$, and the star in Ophiuchus found by Barnard to have a proper motion of $10''.4$ per year. The first of these stars has a parallax of $+ 0''.32$, while Barnard's star has a greater parallax of $+ 0''.53$. Groombridge 1830 has a proper motion of $7''.04$, it is of G5 type, and of magnitude 6.46. One might expect a rather large parallax. It has been very extensively investigated for parallax. With the heliometer, Schluter, Wichmann and Döllen obtained the value of $+ 0''.141 \pm 0''.013$. Also with the heliometer, Johnson and Auwers found the parallax $+ 0''.023 \pm 0''.033$, and with the Yale heliometer, Smith and Chase found the intermediate result of $+ 0''.073 \pm 0''.009$. Three determinations with the meridian circle have been made: Kapteyn deriving the value $+ 0''.139 \pm 0''.026$, Flint the value $- 0''.01 \pm 0''.055$ and Jost the result $+ 0''.085 \pm 0''.024$. In addition, measures have been made by the equatorial by means of the micrometer. Russell by photography finds the value $+ 0''.100 \pm 0''.029$, and Adams with the spectrograph finds the value $+ 0''.083$. The present series of plates were measured by Mr. Mitchell who finds the parallax of $+ 0''.106 \pm 0''.008$. He derives the proper motion in right ascension of $+ 4''.053$ while the value from Boss is $+ 4''.004$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−82.0	+ 5.5	+0.178
2	.10	+19.8	− 0.5	.267
3	.17	+27.1	−52.3	.306
4	.12	+35.1	+47.3	+0.249
Parallax star	0.15	+ 7.8	− 3.4	

TABLE 1

PLATES OF GROOMBRIDGE 1830

No.	Date.	Hour Angle.	Observers.	Weight.
756	1915 Jan. 7	−0h1	M	1.0
797	Jan. 14	−0.3	M	1.0
829	Jan. 28	−0.1	M	0.8
841	Feb. 6	−0.3	M	0.7
1272	May 4	−0.4	M	0.7
1284	May 9	−0.4	M	0.7
1285	May 9	−0.1	M	1.0
1297	May 10	−0.6	Ol	1.0
1316	May 16	−0.2	M	1.0
2162	Dec. 14	−0.5	M	0.7
2163	Dec. 14	−0.1	M	0.7
2172	Dec. 18	−0.9	M	1.0
2173	Dec. 18	−0.5	M	1.0
2182	Dec. 19	−1.0	A	1.0
3526	1916 Dec. 12	−0.5	M	0.9
3613	1917 Jan. 25	−0.6	M	0.7
3657	Feb. 12	−1.0	Ol	0.6
3658	Feb. 12	−0.5	Ol	1.0
3675	Feb. 16	−0.9	A	1.0
3917	Apr. 26	−0.4	A	0.8
3922	May 1	−0.9	M	1.0
3923	May 1	−0.5	M	1.0
3936	May 9	−0.5	A	1.0
3937	May 9	+0.1	A	1.0

TABLE 2

REDUCTIONS FOR GROOMBRIDGE 1830

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
756	+0.0384	1.0	+0.847	−495	+0.0027	+0″.06
797	+ .0451	1.0	+ .802	−488	− .0005	− .01
829	+ .0520	0.8	+ .676	−476	− .0016	− .03
841	+ .0560	0.7	+ .574	−465	− .0003	.00
1272	+ .0966	0.7	− .673	−378	− .0008	− .01
1284	+ .0949	0.7	− .725	−373	+ .0033	+ .06
1285	+ .0999	1.0	− .725	−373	− .0017	− .04
1297	+ .0988	1.0	− .735	−372	− .0001	.00
1316	+ .1018	1.0	− .789	−366	− .0002	.00
2162	+ .2253	0.7	+ .903	−154	− .0019	− .03
2163	+ .2276	0.7	+ .903	−154	− .0042	− .07
2172	+ .2230	1.0	+ .903	−150	+ .0026	+ .05
2173	+ .2244	1.0	+ .903	−150	+ .0012	+ .02
2182	+ .2266	1.0	+ .903	−149	− .0005	− .01
3526	+ .4148	0.9	+ .899	+210	+ .0029	+ .06
3613	+ .4415	0.7	+ .702	+254	− .0013	− .02
3657	+ .4519	0.6	+ .491	+272	− .0032	− .05
3658	+ .4474	1.0	+ .491	+272	+ .0013	+ .03
3675	+ .4522	1.0	+ .437	+276	− .0016	− .03
3917	+ .4839	0.8	− .587	+345	− .0017	− .03
3922	+ .4841	1.0	− .646	+350	+ .0005	+ .01
3923	+ .4848	1.0	− .646	+350	− .0002	.00
3936	+ .4891	1.0	− .730	+358	− .0007	− .01
3937	+0.4857	1.0	−0.730	+358	+0.0027	+0.06

The normal equations are:

$$21.3c - 12.206\mu + 2.6387\pi = + 5.7738 \text{ mm.}$$
$$+ 240.1018\mu - 11.6291\pi = + 9.0844 \text{ mm.}$$
$$+ 11.7431\pi = + 0.2334 \text{ mm.}$$

from which:

$c = + 0.30103$ mm.

$\mu = + 0.05339$ mm. $= + 1''.1104$, or $+ 4''.053$ per year.

$\pi = + 0.00510$ mm. $= + \mathbf{0''.106} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

γ URSÆ MAJORIS ($11^h\ 48^m$; $+54°\ 15'$)

According to Hertzsprung (*Astrophysical Journal*, **30**, 134, 1909), the absolute parallax of this star as a member of the Ursa Major group has been calculated to be 0″.042. It is of A-type, and of magnitude 2.54 with total proper motion 0″.094. Pritchard by photography gave the values of the parallax,

TABLE 1

PLATES OF γ URSÆ MAJORIS

No.	Date.	Hour Angle.	Observers.	Weight.
1218	1915 Apr. 17	−1ʰ0	A	0.9
1233	Apr. 23	−0.6	G	1.0
1315	May 15	−0.1	A	0.7*
2220	Dec. 23	−1.1	A	0.9
2221	Dec. 23	−0.7	A	1.0
2354	1916 Jan. 23	−0.2	G	0.6*
2368	Feb. 3	−1.1	A	1.0
2369	Feb. 3	−0.7	A	1.0
2584	Apr. 20	−0.5	G	1.0
2595	Apr. 26	−0.8	G	0.8
2625	May 1	−0.5	G	1.0
2656	May 14	0.0	M	0.7
3558	1917 Jan. 3	−0.4	A	0.9
3559	Jan. 3	0.0	A	1.0
3587	Jan. 16	−0.3	L	1.0
3588	Jan. 16	0.0	L	0.7*
5281	1918 Apr. 14	−0.8	M	0.7
5282	Apr. 14	−0.4	M	0.8
5355	May 5	−1.0	A	1.0
5356	May 5	−0.6	A	0.6*
5362	May 14	−0.2	A	0.9
6164	Dec. 29	−0.8	M	0.8
6165	Dec. 29	−0.4	M	0.8
6374	1919 Jan. 28	−1.4	F	1.0
6375	Jan. 28	−0.9	F	0.8

* One exposure.

TABLE 2

REDUCTIONS FOR γ URSÆ MAJORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1218	−0.0212	0.9	−0.458	−658	+0.0013	+0″.03
1233	− .0176	1.0	− .538	−652	− .0022	− .05
1315	− .0220	0.7	− .778	−630	+ .0026	+ .05
2220	− .0145	0.9	+ .900	−408	− .0012	− .02
2221	− .0157	1.0	+ .900	−408	.0000	.00
2354	− .0147	0.6	+ .732	−377	− .0004	− .01
2368	− .0170	1.0	+ .617	−366	+ .0021	+ .04
2369	− .0122	1.0	+ .617	−366	− .0027	− .06
2584	− .0150	1.0	− .509	−289	+ .0015	+ .03
2595	− .0119	0.8	− .585	−283	− .0015	− .03
2625	− .0132	1.0	− .644	−279	− .0001	.00
2656	− .0128	0.7	− .776	−265	− .0002	.00
3558	− .0116	0.9	+ .866	− 31	+ .0024	+ .05
3559	− .0088	1.0	+ .866	− 31	− .0004	− .01
3587	− .0104	1.0	+ .785	− 18	+ .0015	+ .03
3588	− .0065	0.7	+ .785	− 18	− .0024	− .04
5281	− .0031	0.7	− .421	+435	+ .0021	+ .04
5282	+ .0008	0.8	− .421	+435	− .0018	− .03
5355	− .0006	1.0	− .683	+456	.0000	.00
5356	− .0011	0.6	− .683	+456	+ .0005	+ .01
5362	+ .0009	0.9	− .772	+465	− .0013	− .03
6164	+ .0004	0.8	+ .886	+694	+ .0030	+ .06
6165	+ .0066	0.8	+ .886	+694	− .0032	− .06
6374	+ .0045	1.0	+ .680	+724	− .0006	− .01
6375	+0.0026	0.8	+0.680	+724	+0.0013	+0.02

+ 0″.099 ± 0″.030 while the meridian circle value by Flint is + 0″.043 ± 0″.058. No other parallax values have been published. The McCormick plates were measured by Mr. Alden with the exception of eight plates that were measured by Mr. Mitchell. The relative parallax from the plates is − 0″.002 ± 0″.007, while the proper motion in right ascension was measured as + 0″.131 while the corresponding value from Boss is + 0″.093.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−41.3	+ 2.8	+0.2013
2	.13	−36.9	+19.2	.2176
3	.09	+ 7.1	+13.9	.2138
4	.10	+11.4	−52.8	.1488
5	.08	+59.7	+16.9	+0.2185
Parallax star	0.15	− 0.1	+ 3.6	

The normal equations are:

$$21.6c - 2.738\mu + 2.9266\pi = - 0.1895 \text{ mm.}$$
$$+ 456.4312\mu + 9.5223\pi = + 0.8121 \text{ mm.}$$
$$+ 11.0024\pi = - 0.0096 \text{ mm.}$$

from which:

$c = - 0.00854$ mm.

$\mu = + 0.00173$ mm. $= + 0''.0360$, or $+ 0''.131$ per year.

$\pi = - 0.00010$ mm. $= - \mathbf{0''.002 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00115 \text{ mm.} = \pm 0''.024.$$

BOSS 3137 ($11^h\ 55^m$; $-9°\ 52'$)

This star, of total proper motion 0″.491 of type G, and of magnitude 5.63, has had its parallax twice determined. The Yale heliometer gives the relative parallax, + 0″.111 ± 0″.015 while the spectroscopic parallax of Adams is + 0″.040. Miss Darkow measured the McCormick plates and determined a relative parallax of + 0″.087 ± 0″.012.

TABLE 1

PLATES OF BOSS 3137

No.	Date.	Hour Angle.	Observers.	Weight.
5084	1918 Feb. 13	−0h4	Ds	0.8
5085	Feb. 13	+0.2	Ds	0.7
5102	Feb. 17	−0.3	Ds	0.4
5103	Feb. 17	+0.2	Ds	0.8
5160	Mar. 3	0.0	Ol	0.8
5349	May 3	+0.1	Ol	0.7
5350	May 3	+0.7	Ol	0.6
5398	May 31	+1.2	Ol	0.7
6236	1919 Jan. 12	−0.6	D	1.0
6273	Jan. 19	−1.2	D	0.9
6274	Jan. 19	−0.6	D	0.9
6462	Feb. 5	−1.3	M	0.9
6463	Feb. 5	−0.7	M	0.6
6912	Apr. 20	−0.2	D	0.7
6913	Apr. 20	+0.6	D	0.5
6950	Apr. 26	+1.2	H	0.9
7001	May 14	+1.2	H	1.0
7023	May 16	+0.6	D	0.7
7025	May 17	+0.2	D	0.9

COMPARISON STARS.

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−43.9	+ 4.2	+0.212
2	.18	− 4.8	− 8.9	+ .238
3	.09	− 4.1	− 7.9	+ .240
4	.12	+52.8	+12.6	+ .310
Parallax star	0.16	+ 4.9	+ 0.8	

TABLE 2

REDUCTIONS FOR BOSS 3137

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
5084	−0.0190	0.8	+0.510	−247	+0.0027	+0″.05
5085	− .0159	0.7	+ .510	−247	− .0004	− .01
5102	− .0128	0.4	+ .457	−243	− .0037	− .05
5103	− .0181	0.8	+ .457	−243	+ .0016	+ .03
5160	− .0162	0.8	+ .254	−229	− .0011	− .02
5349	− .0219	0.7	− .640	−168	+ .0013	+ .02
5350	− .0170	0.6	− .640	−168	− .0036	− .06
5398	− .0221	0.7	− .878	−140	+ .0007	+ .01
6236	− .0090	1.0	+ .830	+ 86	− .0036	− .07
6273	− .0148	0.9	+ ,781	+ 93	+ .0020	+ .04
6274	− .0152	0.9	+ .781	+ 93	+ .0024	+ .05
6462	− .0137	0.9	+ .613	+110	+ .0003	+ .01
6463	− .0108	0.6	+ .613	+110	− .0026	− .04
6912	− .0169	0.7	− .474	+184	− .0005	− .01
6913	− .0225	0.5	− .474	+184	+ .0051	+ .07
6950	− .0160	0.9	− .553	+190	− .0017	− .03
7001	− .0182	1.0	− .752	+208	− .0002	.00
7023	− .0166	0.7	− .770	+210	− .0018	− .03
7025	−0.0202	0.9	−0.778	+211	+0.0017	+0.04

The normal equations are:

$$14.5c + 1.934\mu + 0.1676\pi = -0.2402 \text{ mm.}$$
$$+ 48.317\mu - 4.5624\pi = -0.0171 \text{ mm.}$$
$$+ 6.1851\pi = +0.0198 \text{ mm.}$$

from which:

$c = -0.01671$ mm.

$\mu = +0.00071$ mm. $= +0''.0148$, or $0''.0540$ per year.

$\pi = +0.00418$ mm. $= +\mathbf{0''.087} \pm \mathbf{0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00142 \text{ mm.} = \pm 0''.0305.$$

ϵ CORVI ($12^h\ 5^m$; $-22°\ 3'$)

Miss France measured the plates of this star of magnitude 3.21 and type K. A relative parallax $+ 0''.021 \pm 0''.009$ was determined, and a proper motion in right ascension $- 0''.023$ where the corresponding value from Boss is $- 0''.063$. The absolute parallax by Adams and Joy is $+ 0''.022$.

TABLE 1

PLATES OF ϵ CORVI

No.	Date.	Hour Angle.	Observers.	Weight.
772	1915 Jan. 9	$-0^h.3$	M	0.7
899	Feb. 18	−0.3	G	0.7
900	Feb. 18	+0.3	G	0.7
1234	Apr. 23	−0.2	G	0.9
1298	May 10	0.0	Ol	0.6*
1299	May 10	+0.5	Ol	0.7
2279	1916 Jan. 3	0.0	Ol	0.8
2280	Jan. 3	+0.5	Ol	0.8
2644	May 7	+0.3	M	0.8
2645	May 7	+0.8	M	0.8
6444	1919 Feb. 1	−0.6	M	0.8
6445	Feb. 1	−0.2	M	0.9
6464	Feb. 5	−0.3	M	1.0
6465	Feb. 5	0.0	M	1.0
6880	Apr. 13	+0.2	F	0.9
6881	Apr. 13	+0.6	F	0.9
6922	Apr. 21	+0.8	F	1.0
7085	May 26	+0.3	F	1.0
7086	May 26	+0.7	F	1.0
8333	Dec. 22	−1.0	F	0.8
8414	1920 Jan. 5	−0.8	F	1.0
8415	Jan. 5	−0.3	F	1.0
8531	Jan. 31	−1.0	Ol	0.8
8588	Feb. 13	−0.7	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR ϵ CORVI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
772	+0.0376	0.7	+0.860	−1045	+0.0025	+0″.04
899	+ .0433	0.7	+ .481	−1005	− .0037	− .06
900	+ .0368	0.7	+ .481	−1005	+ .0028	+ .05
1234	+ .0382	0.9	− .479	− 941	+ .0002	.00
1298	+ .0355	0.6	− .685	− 924	+ .0027	+ .04
1299	+ .0410	0.7	− .685	− 924	− .0028	− .05
2279	+ .0386	0.8	+ .885	− 686	+ .0005	+ .01
2280	+ .0403	0.8	+ .885	− 686	− .0012	− .02
2644	+ .0389	0.8	− .661	− 561	− .0018	− .03
2645	+ .0354	0.8	− .661	− 561	+ .0017	+ .03
6444	+ .0376	0.8	+ .684	+ 439	− .0021	− .04
6445	+ .0385	0.9	+ .684	+ 439	− .0030	− .06
6464	+ .0354	1.0	+ .641	+ 443	.0000	.00
6465	+ .0332	1.0	+ .641	+ 443	+ .0022	+ .05
6880	+ .0368	0.9	− .338	+ 510	− .0026	− .05
6881	+ .0357	0.9	− .338	+ 510	− .0015	− .03
6922	+ .0304	1.0	− .452	+ 518	+ .0037	+ .08
7085	+ .0320	1.0	− .829	+ 553	+ .0016	+ .03
7086	+ .0348	1.0	− .829	+ 553	− .0012	− .02
8333	+ .0354	0.8	+ .902	+ 763	− .0007	− .01
8414	+ .0335	1.0	+ .878	+ 777	+ .0012	+ .02
8415	+ .0339	1.0	+ .878	+ 777	+ .0008	+ .02
8531	+ .0337	0.8	+ .696	+ 803	+ .0007	+ .01
8588	+0.0345	1.0	+0.549	+ 816	−0.0003	−0.01

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−57.6	+22.5	+0.245
2	.10	−45.1	−38.7	.167
3	.10	− 4.8	+35.7	.245
4	.10	+25.5	−45.7	.137
5	.12	+82.0	+26.2	+0.206
Parallax star	0.15	− 2.4	+ 6.9	

The normal equations are:

$$20.6c + 16.153\mu + 3.6220\pi = + 0.7423 \text{ mm.}$$
$$+ 1026.4944\mu + 19.7176\pi = + 0.2950 \text{ mm.}$$
$$+ 9.8935\pi = + 0.1350 \text{ mm.}$$

from which:

$c = + 0.03609$ mm.

$\mu = - 0.00030$ mm. $= - 0''.0062$, or $- 0''.023$ per year.

$\pi = + 0.00103$ mm. $= + \mathbf{0''.021 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

β CANUM VENATICORUM ($12^h\ 29^m$; $+41°\ 54'$)

This star of magnitude 4.32, of type G and of total proper motion $0''.758$ has had its parallax determined as follows: Elkin and Chase by the Yale heliometer found the result $+ 0''.089 \pm 0''.038$, Flint with the meridian circle $+ 0''.084 \pm 0''.036$, Allegheny Observatory by photography $+ 0''.109 \pm 0''.006$, while Adams by the spectrograph derived the absolute parallax $+ 0''.120$. Miss Hawes measured the photographs, and found a parallax of $+ 0''.102 \pm 0''.009$, with a proper motion in right ascension of $- 0''.671$ per year, while the corresponding value from Boss is $- 0''.701$.

TABLE 1

PLATES OF β CANUM VENATICORUM

No.	Date.	Hour Angle.	Observers.	Weight.
2223	1915 Dec. 23	−0h4	A	1.0
2224	Dec. 23	0.0	A	0.8
2261	1916 Jan. 2	−0.9	G	0.4
2262	Jan. 2	−0.2	G	0.4
2611	Apr. 28	−0.4	M	0.6
3742	1917 Mar. 9	−0.6	Ol	1.0
4899	Dec. 22	−0.5	B	1.0
4900	Dec. 22	0.0	B	1.0
5334	1918 May 1	−0.1	Ol	1.0
5363	May 14	−0.4	A	1.0
5364	May 14	0.0	A	0.7*
5381	May 18	−0.5	A	1.0
5382	May 18	−0.1	A	1.0
6109	Dec. 18	−1.1	F	1.0
6110	Dec. 18	−0.7	F	1.0
6166	Dec. 29	−0.5	M	1.0
6167	Dec. 29	−0.1	M	1.0
6948	1919 Apr. 26	−0.3	H	1.0
6949	Apr. 26	0.0	H	1.0
6990	May 12	−0.1	D	1.0
7011	May 15	−0.8	H	1.0
7012	May 15	−0.1	H	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−72.5	− 7.0	+0.277
2	.08	−11.6	− 8.8	.252
3	.12	+18.1	+57.5	.259
4	.08	+66.0	−41.7	+0.212
Parallax star	0.12	− 4.3	+ 1.9	

TABLE 2

REDUCTIONS FOR β CANUM VENATICORUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2223	+0.1276	1.0	+0.898	−770	+0.0013	+0″.03
2224	+ .1327	0.8	+ .898	−770	− .0038	− .07
2261	+ .1274	0.4	+ .902	−760	+ .0006	+ .01
2262	+ .1260	0.4	+ .902	−760	+ .0020	+ .03
2611	+ .1089	0.6	− .467	−643	+ .0021	+ .03
3742	+ .0860	1.0	+ .298	−328	+ .0009	+ .02
4899	+ .0674	1.0	+ .897	− 40	− .0030	− .06
4900	+ .0608	1.0	+ .897	− 40	+ .0036	+ .07
5334	+ .0487	1.0	− .501	+ 90	− .0027	− .06
5363	+ .0456	1.0	− .660	+103	− .0015	− .03
5364	+ .0439	0.7	− .660	+103	+ .0002	.00
5381	+ .0430	1.0	− .703	+107	+ .0005	+ .01
5382	+ .0436	1.0	− .703	+107	− .0001	.00
6109	+ .0336	1.0	+ .886	+321	− .0012	− .02
6110	+ .0316	1.0	+ .886	+321	+ .0008	+ .02
6166	+ .0304	1.0	+ .904	+332	+ .0011	+ .02
6167	+ .0321	1.0	+ .904	+332	− .0006	− .01
6948	+ .0140	1.0	− .430	+450	+ .0006	+ .01
6949	+ .0174	1.0	− .430	+450	− .0028	− .06
6990	+ .0106	1.0	− .635	+466	+ .0015	+ .03
7011	+ .0099	1.0	− .668	+469	+ .0018	+ .04
7012	+0.0112	1.0	−0.668	+469	+0.0005	+0.01

The normal equations are:

$$19.9c + 13.013\mu + 1.8698\pi = + 1.0171 \text{ mm.}$$
$$+ 342.5794\mu - 22.3390\pi = - 2.4022 \text{ mm.}$$
$$+ 10.7811\pi = + 0.3557 \text{ mm.}$$

from which:

$c = + 0.05643$ mm.

$\mu = - 0.00884$ mm. $= - 0''.1838$, or $- 0''.671$ per year.

$\pi = + 0.00490$ mm. $= + \mathbf{0''.102 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

θ VIRGINIS ($13^h\ 4^m$; $-5°\ 0'$)

This star of magnitude 4.44, of spectral type A has a small total proper motion 0″.058. It is accompanied by a star of ninth magnitude at a distance of 7″ which shares the motion of the principal star. Mitchell (*Astrophysical Journal*, **30**, 241, 1909) has found the star to be a spectroscopic binary. Mr. Mitchell measured the McCormick plates with the exception of seven plates measured by Mr. Alden. A relative parallax

TABLE 1

PLATES OF θ VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
3588	1917 Jan. 16	$-0^h.4$	L	1.0
3744	Mar. 9	+0.2	A	0.6
3745	Mar. 9	+0.8	A	1.0
3774	Mar. 19	+0.1	A	0.8
3775	Mar. 19	+0.6	A	0.7
3969	May 15	−0.1	M	0.8
4059	June 13	+0.7	A	0.6*
5121	1918 Feb. 22	+0.2	A	0.8
5122	Feb. 22	+0.8	A	0.8
5365	May 14	0.0	A	1.0
5383	May 18	0.0	A	1.0
5384	May 18	+0.4	A	0.7*
5430	June 8	+0.4	A	1.0
5453	June 12	+1.0	A	1.0
6563	1919 Feb. 23	−0.7	M	1.0
6564	Feb. 23	−0.2	M	1.0
6575	Feb. 26	−0.4	M	1.0
6679	Mar. 12	−0.6	H	0.9
6680	Mar. 12	0.0	H	1.0
7013	May 15	+0.4	H	1.0
7014	May 15	−0.9	H	1.0
7037	May 18	−0.5	M	0.9
7038	May 18	0.0	M	0.8

*One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−36.1	+18.3	+0.3062
2	.10	−19.4	−29.0	.2299
3	.13	− 7.7	+ 2.9	.2607
4	.12	+63.2	+ 7.8	+0.2032
Parallax star	0.12	− 4.7	+ 1.3	

TABLE 2

REDUCTIONS FOR θ VIRINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3588	−0.0084	1.0	+0.898	−478	−0.0005	−0″.01
3744	− .0099	0.6	+ .440	−426	+ .0005	+ .01
3745	− .0092	1.0	+ .440	−426	− .0001	.00
3774	− .0096	0.8	+ .296	−416	+ .0002	.00
3775	− .0082	0.7	+ .296	−416	− .0012	− .02
3969	− .0096	0.8	− .560	−359	− .0012	− .02
4059	− .0108	0.6	− .848	−330	+ .0008	+ .01
5121	− .0102	0.8	+ .634	− 76	+ .0007	+ .01
5122	− .0098	0.8	+ .634	− 76	+ .0003	.00
5365	− .0116	1.0	− .544	+ 5	+ .0003	+ .01
5383	− .0122	1.0	− .595	+ 9	+ .0010	+ .02
5384	− .0091	0.7	− .595	+ 9	− .0021	− .03
5430	− .0124	1.0	− .809	+ 30	+ .0011	+ .02
5453	− .0112	1.0	− .840	+ 34	− .0002	.00
6563	− .0126	1.0	+ .626	+290	+ .0007	+ .02
6564	− .0146	1.0	+ .626	+290	+ .0027	+ .06
6575	− .0106	1.0	+ .591	+293	− .0013	− .03
6679	− .0108	0.9	+ .406	+307	− .0012	− .02
6680	− .0123	1.0	+ .406	+307	+ .0003	+ .01
7013	− .0124	1.0	− .554	+371	− .0001	.00
7014	− .0126	1.0	− .554	+371	+ .0001	.00
7037	− .0127	0.9	− .591	+374	+ .0001	.00
7038	−0.0102	0.8	−0.591	+374	−0.0024	−0.04

$+ 0''.006 \pm 0''.006$ was determined, with a proper motion in right ascension $- 0''.029$ where the corresponding value from Boss is $- 0''.039$. No other parallax has been determined.

The normal equations are:

$$20.4c + 5.280\mu - 0.5992\pi = - 0.2263 \text{ mm.}$$
$$+ 190.4528\mu - 7.4063\pi = - 0.1317 \text{ mm.}$$
$$+ 7.4848\pi = + 0.0115 \text{ mm.}$$

from which:

$c = - 0.01099$ mm.
$\mu = - 0.00038$ mm. $= - 0''.0078$, or $- 0''.029$ per year.
$\pi = + 0.00028$ mm. $= \mathbf{+ 0''.006 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00074 \text{ mm.} = \pm 0''.015.$$

β COMÆ BERENICIS ($13^h\ 7^m$; $+28°\ 23'$)

The star has considerable proper motion amounting to $1''.18$ per year. It is of magnitude 4.32 and of spectral type G. Four determinations of its parallax have been published as follows:

Authority.	Method.	Parallax.
Peter	Heliometer	$+0''.11 \pm 0''.021$
Flint	Meridian circle	$+ .08 \pm .053$
Chase	Heliometer	$+ .118 \pm .052$
Adams	Spectrograph	$+0.132$

Mr. Alden measured the McCormick plates, and derived a relative parallax of $+ 0''.140 \pm 0''.013$ with a proper motion in right ascension of $- 0''.798$ while the value from Boss is $- 0''.797$.

TABLE 1

PLATES OF β COMÆ

No.	Date.	Hour Angle.	Observers.	Weight.
929	1915 Feb. 20	−0ʰ5	G	0.7
980	Mar. 2	−0.8	G	1.0
1005	Mar. 8	−0.8	M	0.7
1028	Mar. 10	−0.8	G	0.9
2263	1916 Jan. 2	−0.3	G	0.8
2355	Jan. 23	−0.8	G	0.6
2381	Feb. 7	−0.7	G	0.7
2434	Mar. 3	−0.5	Ol	0.7
2665	May 17	−0.8	Ol	0.8
2666	May 17	−0.4	Ol	0.7*
2678	May 26	−0.6	Ol	0.7
2679	May 26	−0.2	Ol	0.7*
2698	June 2	−0.1	G	0.7
3701	1917 Feb. 24	−1.5	Ol	1.0
3702	Feb. 24	−0.8	Ol	1.0
3707	Mar. 5	−0.8	Ol	0.5
3720	Mar. 6	−1.1	L	0.5
3743	Mar. 9	−0.6	A	1.0
3938	May 9	−0.7	A	1.0
3939	May 9	−0.3	A	1.0
3956	May 14	−0.4	M	0.5*

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−65.7	+12.0	+0.1687
2	.18	−15.6	−46.3	.1821
3	.12	+10.6	+58.4	.2180
4	.12	+26.3	−26.1	.2080
5	.11	+44.4	+ 2.0	+0.2232
Parallax star	0.16	+ 3.8	+ 1.3	

TABLE 2

REDUCTIONS FOR β COMÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
929	+0.0033	0.7	+0.667	−449	−0.0001	0″.00
980	− .0006	1.0	+ .550	−439	+ .0020	+ .04
1005	+ .0030	0.7	+ .471	−433	− .0028	− .05
1028	+ .0017	0.9	+ .443	−431	− .0019	− .04
2263	− .0304	0.8	+ .903	−133	+ .0020	+ .04
2355	− .0305	0.6	+ .881	−112	− .0002	.00
2381	− .0320	0.7	+ .792	− 97	− .0009	− .02
2434	− .0400	0.7	+ .527	− 72	+ .0027	+ .05
2665	− .0545	0.8	− .580	+ 3	+ .0018	+ .04
2666	− .0507	0.7	− .580	+ 3	− .0020	− .03
2678	− .0562	0.7	− .685	+ 12	+ .0019	+ .03
2679	− .0522	0.7	− .685	+ 12	− .0021	− .04
2698	− .0562	0.7	− .756	+ 19	+ .0007	+ .01
3701	− .0718	1.0	+ .617	+286	− .0025	− .05
3702	− .0741	1.0	+ .617	+286	− .0002	.00
3707	− .0812	0.5	+ .504	+295	+ .0052	+ .07
3720	− .0812	0.5	+ .491	+296	+ .0050	+ .07
3743	− .0730	1.0	+ .450	+299	− .0038	− .08
3938	− .0880	1.0	− .473	+360	− .0014	− .03
3939	− .0906	1.0	− .473	+360	+ .0012	+ .02
3956	−0.0909	0.5	−0.539	+365	+0.0005	+0.01

The normal equations are:

$$16.2c + 3.674\mu + 2.5274\pi = -0.8061 \text{ mm.}$$
$$+ 133.0755\mu - 8.2993\pi = -1.6320 \text{ mm.}$$
$$+ 6.0631\pi = +0.0056 \text{ mm.}$$

from which:

$c = -0.04843$ mm.

$\mu = -0.01051$ mm. $= -0''.2185$, or $-0''.798$ per year.

$\pi = +0.00673$ mm. $= +\mathbf{0''.140 \pm 0''.013}$.

Probable error of plate of unit weight

$$\pm 0.00145 \text{ mm.} = \pm 0''.030.$$

61 VIRGINIS ($13^h\ 13^m$; $-17°\ 45'$)

This star of considerable proper motion 1.51 per year, is of magnitude 4.80, and of spectral type K. The only trigonometric parallax is that of Flint with the meridian circle who determines the relative parallax $+ 0''.14 \pm 0''.033$. The absolute parallax of Adams and Joy is $+ 0''.105$. The majority of the McCormick plates were measured by Mr. Lamb, though some were measured

TABLE 1

PLATES OF 61 VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
969	1915 Mar. 1	$+0^h.2$	M	0.7
1041	Mar. 12	−0.6	G	0.4
1063	Mar. 14	−0.5	G	0.4*
1099	Mar. 22	0.0	G	0.8
2646	1916 May 7	+0.4	M	1.0
2647	May 7	+0.9	M	0.8
2734	June 19	+0.9	Ol, L	0.8
3680	1917 Feb. 20	−1.0	L	1.0
3681	Feb. 20	−0.7	L	1.0
3720	Mar. 6	−0.6	L	0.8
3721	Mar. 6	−0.2	L	0.9
3958	May 14	+0.5	M	0.7
3959	May 14	+0.9	M	0.7
4055	June 11	+0.6	Ol	1.0
4056	June 11	+0.8	M	1.0
4058	June 13	+0.4	A	1.0
5086	1918 Feb. 13	−0.4	Ds	0.9
5087	Feb. 13	+0.1	Ds	1.0
5104	Feb. 17	−0.5	Ds	0.9
5105	Feb. 17	0.0	Ds	0.9
5412	June 4	−0.2	L	1.0
5413	June 4	+0.4	L	1.0
5440	June 9	+0.1	L	0.8
5441	June 9	+0.6	L	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR 61 VIRGINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
969	−0.0048	0.7	+0.583	−730	+0.0046	+0″.08
1041	− .0028	0.4	+ .439	−719	+ .0002	.00
1063	− .0052	0.4	+ .411	−717	+ .0022	+ .03
1099	− .0012	0.8	+ .294	−709	− .0036	− .07
2646	− .0638	1.0	− .426	−297	− .0003	− .01
2647	− .0639	0.8	− .426	−297	− .0002	.00
2734	− .0706	0.8	− .874	−254	− .0021	− .04
3680	− .0986	1.0	+ .680	− 8	+ .0029	+ .06
3681	− .0990	1.0	+ .680	− 8	+ .0033	+ .07
3720	− .0961	0.8	+ .513	+ 6	− .0025	− .05
3721	− .0932	0.9	+ .513	+ 6	− .0054	− .11
3958	− .1152	0.7	− .519	+ 75	+ .0009	+ .02
3959	− .1113	0.7	− .519	+ 75	− .0030	− .05
4055	− .1188	1.0	− .818	+103	− .0010	− .02
4056	− .1204	1.0	− .818	+103	+ .0006	+ .01
4058	− .1232	1.0	− .833	+105	+ .0030	+ .06
5086	− .1430	0.9	+ .751	+350	.0000	.00
5087	− .1408	1.0	+ .751	+350	− .0022	− .05
5104	− .1438	0.9	+ .714	+354	+ .0001	.00
5105	− .1446	0.9	+ .714	+354	+ .0009	+ .02
5412	− .1681	1.0	− .755	+461	+ .0010	+ .02
5413	− .1656	1.0	− .755	+461	− .0015	− .03
5440	− .1685	0.8	− .800	+466	+ .0004	+ .01
5441	−0.1700	1.0	−0.800	+466	+0.0019	+0.04

by Mr. Mitchell and also by Mr. Briggs. A parallax + 0″.130 ± 0″.011 resulted, and a proper motion in right ascension − 1″.011 while the corresponding value from Boss is − 1″.077.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−32.8	+ 5.1	+0.2661
2	.15	−14.9	− 9.1	.2760
3	.09	− 3.6	+36.7	.1926
4	.10	+51.3	−32.7	+0.2653
Parallax star	0.12	+ 0.1	− 2.8	

The normal equations are:

$$20.5c + 10.828\mu - 1.6841\pi = - 2.2258 \text{ mm.}$$
$$+ 271.2533\mu - 10.3235\pi = - 4.7702 \text{ mm.}$$
$$+ 9.4522\pi = + 0.3665 \text{ mm.}$$

from which:

$c = - 0.10103$ mm.

$\mu = - 0.01332$ mm. $= - 0''.2770$, or $- 1''.011$ per year.

$\pi = + 0.00623$ mm. $= + \mathbf{0''.130 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00155 \text{ mm.} = \pm 0''.032.$$

γ HYDRÆ ($13^h\ 13^m$; $-22°\ 38'$)

The only parallax determined is the absolute value from the spectroscope at Mt. Wilson + 0″.022. The star is of magnitude 3.33, of type G5, and of total proper motion 0″.084. Mr. Olivier measured the plates and derived a relative parallax + 0″.007 ± 0″.010, with a proper motion in right ascension + 0″.176 where the corresponding value from Boss is + 0″.067.

TABLE 1

PLATES OF γ HYDRÆ

No.	Date.	Hour Angle.	Observers.	Weight.
1357	1915 June 10	$+0^h.2$	Ol	1.0
1358	June 10	+0.7	Ol	0.9
2281	1916 Jan. 3	0.0	Ol	0.9
2294	Jan. 7	+0.2	Ol	0.6
2660	May 14	+0.6	M	0.9
2672	May 19	−0.7	Ol	0.8
2673	May 19	−0.2	Ol	1.0
3693	1917 Feb. 22	+0.6	M	1.0
3694	Feb. 22	+0.9	M	0.6*
3703	Feb. 24	−0.1	Ol	0.9
3704	Feb. 24	+0.3	Ol	0.9
3991	May 23	+0.4	Ol	1.0
3992	May 23	+0.8	Ol	0.9
4009	May 25	+0.2	M	1.0
4010	May 25	+0.6	M	0.9
4027	June 4	−0.3	Ol	0.9
4028	June 4	+0.1	Ol	0.9
4915	Dec. 27	−0.4	Ol	0.9
5029	1918 Feb. 7	−0.2	Ol	0.7
5030	Feb. 7	+0.5	Ol	0.7
5163	Mar. 3	+1.0	Ol	0.9
5164	Mar. 3	+1.5	Ol	0.8
7217	1919 June 22	+1.2	F	0.9
7218	June 22	+1.8	F	0.9
7228	June 28	+1.8	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension.)	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−54.4	+ 8.9	+0.3001
2	.12	+16.0	+24.0	.3156
3	.14	+38.4	−32.9	+0.3833
Parallax star	0.18	+ 3.4	− 2.4	

TABLE 2

REDUCTIONS FOR γ HYDRÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1357	−0.0014	1.0	−0.806	−702	+0.0034	+0″.07
1358	+ .0004	0.9	− .806	−702	+ .0016	+ .03
2281	+ .0084	0.9	+ .903	−495	− .0010	− .02
2294	+ .0098	0.6	+ .909	−491	− .0023	− .04
2660	+ .0104	0.9	− .522	−363	− .0004	− .01
2672	+ .0128	0.8	− .585	−358	− .0028	− .05
2673	+ .0084	1.0	− .585	−358	+ .0016	+ .03
3693	+ .0150	1.0	+ .658	− 79	+ .0019	+ .04
3694	+ .0147	0.6	+ .658	− 79	+ .0022	+ .04
3703	+ .0175	0.9	+ .636	− 77	− .0005	− .01
3704	+ .0136	0.9	+ .636	− 77	+ .0034	+ .07
3991	+ .0168	1.0	− .631	+ 11	+ .0018	+ .04
3992	+ .0220	0.9	− .631	+ 11	− .0034	− .07
4009	+ .0223	1.0	− .652	+ 13	− .0037	− .08
4010	+ .0233	0.9	− .652	+ 13	− .0047	− .09
4027	+ .0190	0.9	− .757	+ 23	− .0002	.00
4028	+ .0194	0.9	− .757	+ 23	− .0006	− .01
4915	+ .0227	0.9	+ .884	+229	+ .0014	+ .03
5029	+ .0286	0.7	+ .801	+271	− .0035	− .06
5030	+ .0287	0.7	+ .801	+271	− .0036	− .06
5163	+ .0252	0.9	+ .554	+295	+ .0003	+ .01
5164	+ .0227	0.8	+ .554	+295	+ .0028	+ .05
7217	+ .0346	0.9	− .887	+771	+ .0015	+ .03
7218	+ .0358	0.9	− .887	+771	+ .0003	.00
7228	+0.0338	0.9	−0.914	+777	+0.0024	+0.05

The normal equations are:

$$21.8c - 0.489\mu - 2.8592\pi = + 0.4018 \text{ mm.}$$
$$+ 358.4254\mu - 3.8569\pi = + 0.8184 \text{ mm.}$$
$$+ 11.6331\pi = - 0.0580 \text{ mm.}$$

from which:

$c = + 0.01853$ mm.

$\mu = + 0.00231$ mm. $= + 0''.0481$, or $+ 0''.176$ per year.

$\pi = + 0.00034$ mm. $= + \mathbf{0''.007 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00161 \text{ mm.} = \pm 0''.033.$$

ζ URSÆ MAJORIS ($13^h\ 19^m$; $+55°\ 26'$)

Mizar and Alcor in the "Big Dipper" are well known. The former is a visual double of 2.40 and 3.96 magnitudes, and of types Ap and A2, respectively, and separated by an angular distance of 14″. The brighter of these has the distinction of being the first star discovered as a spectroscopic binary. This was accomplished by Pickering (*Amer. Jour. Sci.*, **39**, 46, 1890). The fainter of the two stars is likewise a spectroscopic binary, and was discovered by Frost and Lee (*Astronomische Nachrichten*, **177**, 171, 1908). Mizar and its visual companion have a nearly common proper motion, which is also shared by Alcor. These three stars ζ^1, ζ^2 and g Ursæ Majoris belong to the Ursa Major group. The parallaxes of all three were measured by Mr. Mitchell. They unquestionably form a physical system, and must have the same value of the parallax. The mean value of the parallax of the three stars ζ^1, ζ^2 and g Ursæ Majoris is:

$$\mathbf{+ 0''.031 \pm 0''.005}.$$

Flint with the meridian circle finds the result for Mizar, $+ 0''.076 \pm 0''.033$, and Smith with the Yale heliometer, the value, $+ 0''.007 \pm 0''.011$. For the companion Adams and Joy find the spectroscopic parallax $+ 0''.023$. According to Hertzsprung (*Astrophysical Journal*, **30**, 134, 1909), the theoretical value of the absolute parallax of ζ Ursæ Majoris should be $+ 0''.043$. The annual proper motion in right ascension from the photographs for Mizar and companion amounts to $+ 0''.108$ and $+ 0''.103$, respectively. Boss gives the values $+ 0''.126$ and $+ 0''.132$.

TABLE 1

PLATES OF ζ URSÆ MAJORIS

No.	Date.	Hour Angle.	Observers.	Weight.
757	1915 Jan. 7	−0^{h}8	M	0.9
758	Jan. 7	−0.2	M	0.8
798	Jan. 14	−0.5	M	0.9
842	Feb. 6	−1.2	M	0.9
2658	1916 May 14	−0.9	M	0.7
2659	May 14	−0.4	M	0.7
2674	May 21	−1.6	M	0.7
2675	May 21	−1.2	M	0.9
2700	June 3	−0.6	A	0.8
2701	June 3	−0.1	A	0.9
3615	1917 Jan. 25	−0.8	M	1.0
3691	Feb. 22	−0.6	M	0.8
3692	Feb. 22	−0.1	M	1.0
3799	Mar. 24	−0.5	L, Ol	0.8
3800	Mar. 24	−0.1	Ol	1.0
4003	May 24	−1.4	M	1.0
4004	May 24	−1.0	M	1.0
4039	June 7	−0.2	A	1.0
5041	1918 Feb. 9	−0.9	M	0.7
5161	Mar. 3	−0.6	Ol	0.7
5162	Mar. 3	0.0	Ol	0.8
5175	Mar. 5	−0.4	A	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.	
				Principal Star.	Companion
	mm.	mm.	mm.		
1	0.10	−44.9	− 9.8	+0.309	+0.306
2	.17	−13.7	+39.0	.270	.265
3	.18	+ 1.3	−38.6	.161	.165
4	.14	+26.7	−39.0	.094	.100
5	.15	+30.0	+48.4	+0.166	+0.164
Principal star	.20	− 9.7	+ 5.6		
Companion	0.11	− 9.4	+ 5.0		

TABLE 2

REDUCTIONS FOR ζ URSÆ MAJORIS, PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
757	−0.0025	0.9	+0.909	−645	−0.0015	−0″.03
758	− .0060	0.8	+ .909	−645	+ .0020	+ .04
798	− .0064	0.9	+ .912	−638	+ .0025	+ .05
842	− .0010	0.9	+ .825	−615	− .0027	− .05
2658	+ .0010	0.7	− .498	−150	− .0010	− .02
2659	+ .0013	0.7	− .498	−150	− .0013	− .02
2674	− .0022	0.7	− .588	−143	+ .0021	+ .04
2675	− .0001	0.9	− .588	−143	.0000	.00
2700	+ .0002	0.8	− .734	−132	− .0005	− .01
2701	+ .0022	0.9	− .734	−132	− .0025	− .05
3615	+ .0041	1.0	+ .886	+104	+ .0026	+ .05
3691	+ .0080	0.8	+ .679	+132	− .0014	− .03
3692	+ .0073	1.0	+ .679	+132	− .0007	− .01
3799	+ .0037	0.8	+ .283	+162	+ .0024	+ .05
3800	+ .0070	1.0	+ .283	+162	− .0008	− .02
4003	+ .0034	1.0	− .622	+223	+ .0016	+ .03
4004	+ .0040	1.0	− .622	+223	+ .0010	+ .02
4039	+ .0044	1.0	− .770	+237	+ .0005	+ .01
5041	+ .0132	0.7	+ .801	+484	− .0013	− .02
5161	+ .0168	0.7	+ .578	+506	− .0051	− .09
5162	+ .0088	0.8	+ .578	+506	+ .0029	+ .05
5175	+0.0118	1.0	+0.553	+508	−0.0001	0.00

The normal equations are:

$$19.0c + 0.346\mu + 2.8071\pi = + 0.0678 \text{ mm.}$$
$$+ 255.8966\mu - 7.0610\pi = + 0.3501 \text{ mm.}$$
$$+ 8.9638\pi = + 0.0187 \text{ mm.}$$

from which:

$c = + 0.00322$ mm.

$\mu = + 0.00142$ mm. $= + 0''.0296$, or $+ 0''.108$ per year.

$\pi = + 0.00220$ mm. $= + \mathbf{0''.046 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

TABLE 3

REDUCTIONS FOR ζ URSÆ MAJORIS, COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
757	+0.0287	0.9	+0.909	−645	−0.0022	−0″.04
758	+ .0248	0.8	+ .909	−645	+ .0017	+ .03
798	+ .0240	0.9	+ .912	−638	+ .0026	+ .05
842	+ .0285	0.9	+ .825	−615	− .0016	− .03
2658	+ .0313	0.7	− .498	−150	+ .0008	+ .01
2659	+ .0335	0.7	− .498	−150	− .0014	− .02
2674	+ .0279	0.7	− .588	−143	+ .0042	+ .07
2675	+ .0338	0.9	− .588	−143	− .0017	− .03
2700	+ .0326	0.8	− .734	−132	− .0004	− .01
2701	+ .0335	0.9	− .734	−132	− .0013	− .03
3615	+ .0383	1.0	+ .886	+104	− .0017	− .04
3691	+ .0373	0.8	+ .679	+132	− .0004	− .01
3692	+ .0372	1.0	+ .679	+132	− .0003	− .01
3799	+ .0352	0.8	+ .283	+162	+ .0018	+ .03
3800	+ .0354	1.0	+ .283	+162	+ .0016	+ .03
4003	+ .0366	1.0	− .622	+223	+ .0005	+ .01
4004	+ .0368	1.0	− .622	+223	+ .0003	+ .01
4039	+ .0382	1.0	− .770	+237	− .0011	− .02
5041	+ .0430	0.7	+ .801	+484	− .0013	− .02
5161	+ .0408	0.7	+ .578	+506	+ .0010	+ .02
5162	+ .0379	0.8	+ .578	+506	+ .0040	+ .07
5175	+0.0449	1.0	+0.553	+508	−0.0030	−0.06

The normal equations are:

$$19.0c + 0.346\mu + 2.8071\pi = + 0.6588 \text{ mm.}$$
$$+ 255.8966\mu - 7.0610\pi = + 0.3534 \text{ mm.}$$
$$+ 8.9638\pi = + 0.0945 \text{ mm.}$$

from which:

$c = +0.03453$ mm.
$\mu = +0.00136$ mm. $= +0''.0282$, or $+0''.103$ per year.
$\pi = +0.00079$ mm. $= +0''.017 \pm 0''.009$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

g URSÆ MAJORIS ($13^h\ 21^m$; $+55°\ 30'$)

Like both of the components of Mizar, Alcor or "The Rider" is a spectroscopic binary which was discovered by Frost (*Astronomische Nachrichten*, **177**, 172, 1908). The only value of the parallax published is that of the Allegheny Observatory with a result of $+0''.035 \pm 0''.005$. The star is of 4.02 magnitude and A5 type. The McCormick plates give a proper motion in right ascension of $+0''.123$ while the value from Boss is $+0''.122$. The plates were measured by Mr. Mitchell. As a member of the Ursa Major Group, this star should have the theoretical parallax of $+0''.042$. Table I for g Ursæ Majoris containing a list of the plates measured is identical with Table I of ζ Ursæ Majoris (*q. v.*).

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
2	0.17	−37.1	+27.4	+0.238
3	.18	−22.6	−50.1	.179
4	.14	+ 2.8	−50.4	.166
5	.15	+ 6.1	+36.9	.221
6	.15	+50.8	+36.2	+0.196
Parallax star	0.14	− 1.1	+ 4.4	

TABLE 2

REDUCTIONS FOR g URSÆ MAJORIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
757	+0.0109	0.9	+0.909	−645	+0.0011	+0″.02
758	+ .0095	0.8	+ .909	−645	+ .0025	+ .05
798	+ .0118	0.9	+ .912	−638	+ .0003	+ .01
842	+ .0110	0.9	+ .825	−615	+ .0013	+ .03
2658	+ .0214	0.7	− .498	−150	− .0034	− .06
2659	+ .0168	0.7	− .498	−150	+ .0012	+ .02
2674	+ .0187	0.7	− .588	−143	− .0007	− .01
2675	+ .0208	0.9	− .588	−143	− .0028	− .06
2700	+ .0212	0.8	− .734	−132	− .0032	− .06
2701	+ .0166	0.9	− .734	−132	+ .0014	+ .03
3615	+ .0281	1.0	+ .886	+104	− .0040	− .08
3691	+ .0256	0.8	+ .679	+132	− .0014	− .02
3692	+ .0252	1.0	+ .679	+132	− .0010	− .02
3799	+ .0245	0.8	+ .283	+162	− .0003	− .01
3800	+ .0252	1.0	+ .283	+162	− .0010	− .02
4003	+ .0210	1.0	− .622	+223	+ .0029	+ .06
4004	+ .0230	1.0	− .622	+223	+ .0009	+ .02
4039	+ .0218	1.0	− .770	+237	+ .0021	+ .04
5041	+ .0294	0.7	+ .801	+484	+ .0007	+ .01
5161	+ .0298	0.7	+ .578	+506	+ .0004	+ .01
5162	+ .0293	0.8	+ .578	+506	+ .0009	+ .02
5175	+0.0286	1.0	+0.553	+508	+0.0016	+0.03

The normal equations are:

$$19.0c + 0.346\mu + 2.8071\pi = + 0.4062 \text{ mm.}$$
$$+ 255.8966\mu - 7.0610\pi = + 0.4123 \text{ mm.}$$
$$+ 8.9638\pi = + 0.0606 \text{ mm.}$$

from which:

$c = + 0.02114$ mm.

$\mu = + 0.00162$ mm. $= + 0''.0337$, or $+ 0''.123$ per year.

$\pi = + 0.00142$ mm. $= + \mathbf{0''.029} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00130 \text{ mm.} = \pm 0''.027.$$

70 VIRGINIS ($13^h\ 23^m$; $+14°\ 19'$)

This is a star of G5 type, of magnitude 5.16, and of total proper motion 0″.63 per year. Three values have been found for

TABLE 1

PLATES OF 70 VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
773	1915 Jan. 9	0^h0	M	0.9
774	Jan. 9	+0.3	M	0.7*
813	Jan. 20	−0.8	G	0.9
1321	May 21	−0.9	A	1.0
1322	May 21	−0.5	A	1.0
1407	June 28	+1.2	A	1.0
2314	1916 Jan. 13	−0.8	M	0.7
2315	Jan. 13	−0.4	M	0.8
2431	Feb. 29	−1.2	M	0.8
2462	Mar. 11	−1.1	M	1.0
3659	1917 Feb. 12	−1.2	Ol	0.8
3660	Feb. 12	−0.8	Ol	0.8
3708	Mar. 5	−0.4	Ol	1.0
3709	Mar. 5	+0.3	Ol	0.9
3746	Mar. 9	+1.2	A	1.0
3970	May 15	+0.1	M	0.9
3971	May 15	+0.5	M	1.0
3981	May 19	−0.3	Ol	1.0
3982	May 19	+0.1	Ol	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−18.4	+28.9	+0.2641
2	.18	−17.9	−42.9	.2406
3	.25	+ 9.3	− 9.2	.2447
4	.14	+27.0	+23.2	+0.2506
Parallax star	0.19	− 0.1	+ 0.9	

the parallax, the heliometer value by Elkin of Yale + 0″.136 ± 0″.049, the Allegheny result + 0″.032 ± 0″.008 and the spectroscopic value of Adams + 0″.050. The plates of the series were measured by Mr. Alden who found the annual proper motion in right ascension to be − 0″.250 while Boss gives the result − 0″.243.

TABLE 2

REDUCTIONS FOR 70 VIRGINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
773	+0.0091	0.9	+0.911	−491	−0.0005	−0″.01
774	+ .0063	0.7	+ .911	−491	+ .0023	+ .04
813	+ .0082	0.9	+ .906	−480	.0000	.00
1321	− .0008	1.0	− .567	−359	+ .0018	+ .04
1322	+ .0032	1.0	− .567	−359	− .0022	− .05
1407	− .0010	1.0	− .907	−321	.0000	.00
2314	− .0043	0.7	+ .913	−122	+ .0007	+ .01
2315	− .0046	0.8	+ .913	−122	+ .0010	+ .02
2431	− .0036	0.8	+ .621	− 75	− .0022	− .04
2462	− .0052	1.0	+ .482	− 64	− .0012	− .02
3659	− .0187	0.8	+ .784	+274	+ .0018	+ .03
3660	− .0166	0.8	+ .784	+274	− .0003	− .01
3708	− .0156	1.0	+ .563	+295	− .0025	− .05
3709	− .0200	0.9	+ .563	+295	+ .0019	+ .04
3746	− .0172	1.0	+ .511	+299	− .0011	− .02
3970	− .0238	0.9	− .495	+366	+ .0011	+ .02
3971	− .0246	1.0	− .495	+366	+ .0019	+ .04
3981	− .0229	1.0	− .548	+370	.0000	.00
3982	−0.0216	1.0	−0.548	+370	−0.0013	−0.03

The normal equations are:

$$17.2c + 1.697\mu + 3.3789\pi = -0.1630 \text{ mm.}$$
$$+ 188.8001\mu - 5.8169\pi = -0.6501 \text{ mm.}$$
$$+ 8.2364\pi = +0.0046 \text{ mm.}$$

from which:

$c = -0.00957$ mm.
$\mu = -0.00329$ mm. $= -0''.0684$, or $-0''.250$ per year.
$\pi = +0.00217$ mm. $= +0''.045 \pm 0''.008$.

Probable error corresponding to unit weight

$$\pm 0.00104 \text{ mm.} = \pm 0''.022.$$

o 78 VIRGINIS ($13^h\ 29^m$; $+4°\ 10'$)

According to Bottlinger (*Astronomische Nachrichten*, 4738) this star forms one of the Ursa Major group with a theoretical parallax of $+0''.014$. Mitchell (*Astrophysical Journal*, **30**, 241, 1909) has found it to be a spectroscopic binary. It is of Ap type, and of magnitude 4.93, with a total proper motion of $0''.05$ per year. Mr. Alden measured the series of plates and derived the annual proper motion in right ascension of $+0''.052$, while Boss obtained the value $+0''.042$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−29.9	−17.5	+0.2257
2	.25	− 5.4	+46.0	.2575
3	.09	+15.1	−27.7	.2535
4	.11	+20.2	− 0.8	+0.2633
Parallax star	0.17	+ 1.0	+ 0.7	

TABLE 1

PLATES OF o 78 VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
1029	1915 Mar. 10	−0h4	G	1.0
1042	Mar. 12	0.0	G	0.8
1064	Mar. 14	−0.1	G	0.7
1323	May 22	+0.6	G	0.7*
1332	June 4	+0.4	G	1.0
1347	June 9	0.0	G	1.0
1348	June 9	+0.6	G	0.9
1384	June 23	+1.1	G	0.9
2357	1916 Jan. 23	+0.2	G	0.7
2358	Jan. 23	+0.9	G	0.6
2383	Feb. 7	+0.5	G	0.7
2502	Mar. 17	−0.4	G	0.8
2503	Mar. 17	+0.3	G	0.7
3782	1917 Mar. 21	−0.4	L	0.8
3783	Mar. 21	+0.1	L	0.8
3813	Mar. 25	−0.4	M, L	0.7
3814	Mar. 25	0.0	L	0.8
4040	June 7	+0.2	A	1.0
4074	June 17	+0.5	M, B	0.9
4075	June 17	+0.9	M, B	1.0
4085	June 18	+0.5	A, B	0.8
4098	June 22	+1.0	Ol, B	0.8

* One exposure.

TABLE 2

REDUCTIONS FOR υ 78 VIRGINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1029	+0.0024	1.0	+0.526	−422	+0.0004	+0″.01
1042	.0000	0.8	+ .499	−420	+ .0027	+ .05
1064	+ .0061	0.7	+ .472	−418	− .0034	− .06
1323	+ .0040	0.7	− .562	−349	− .0020	− .04
1332	+ .0022	1.0	− .712	−336	− .0002	.00
1347	+ .0032	1.0	− .762	−331	− .0013	− .03
1348	− .0008	0.9	− .762	−331	+ .0027	+ .05
1384	+ .0030	0.9	− .871	−317	− .0011	− .02
2357	+ .0016	0.7	+ .905	−103	+ .0038	+ .07
2358	+ .0032	0.6	+ .905	−103	+ .0022	+ .03
2383	+ .0094	0.7	+ .838	− 88	− .0040	− .07
2502	+ .0039	0.8	+ .420	− 49	+ .0013	+ .02
2503	+ .0050	0.7	+ .420	− 49	+ .0002	.00
3782	+ .0108	0.8	+ .366	+320	− .0032	− .06
3783	+ .0072	0.8	+ .366	+320	+ .0004	+ .01
3813	+ .0072	0.7	+ .307	+324	+ .0004	+ .01
3814	+ .0094	0.8	+ .307	+324	− .0018	− .03
4040	+ .0042	1.0	− .748	+398	+ .0027	+ .06
4074	+ .0036	0.9	− .834	+408	+ .0033	+ .06
4075	+ .0088	1.0	− .834	+408	− .0019	− .04
4085	+ .0057	0.8	− .841	+409	+ .0012	+ .02
4098	+0.0101	0.8	−0.868	+413	−0.0032	−0.06

The normal equations are:

$$18.1c + 0.147\mu - 2.3421\pi = + 0.0889 \text{ mm.}$$
$$+ 202.7357\mu - 7.9676\pi = + 0.1306 \text{ mm.}$$
$$+ 8.3721\pi = - 0.0080 \text{ mm.}$$

from which:

$c = + 0.00505$ mm.

$\mu = + 0.00068$ mm. $= + 0''.0142$, or $+ 0''.052$ per year.

$\pi = + 0.00111$ mm. $= +$ **0″.023 ± 0″.010.**

Probable error of plate of unit weight

$= \pm 0.00134$ mm. $= \pm 0''.028.$

LALANDE 25224 ($13^h\ 34^m$; $+11°\ 15'$)

This is best known as a visual binary in rapid motion, β 612. It is a close and difficult double, discovered by Burnham in 1878, and whose components are less than 0″.4 distant. With the observations to 1892, Glasenapp finds a period of 30.0 years. With measures up to 1912, Aitken (*Lick Observatory Publications*, **12**, 85), derives the period of 23.05 years. The components are nearly of the same brightness, each being of 6.5 magnitude. Four values of the parallax have been determined, that of Flint by means of the meridian circle who gives the value + 0″.25 ± 0″.098, − 0″.016 ± 0″.012 from measures by Miss Steele of photographs taken at Swarthmore, − 0″.001 ± 0″.008 and + 0″.019 ± 0″.008 from photographs at Allegheny and Yerkes respectively. The rotating sector was utilized to diminish the brightness of the parallax star, and on account of the equal brightness of the components, the value of the proper motion below must refer to the center of brightness. The plates were measured by Mr. Lamb. Boss gives the value of the proper motion in right ascension of the center of gravity of the system to be − 0″.112, while the McCormick value is − 0″.054. From Aitken's orbit, it is found that the McCormick value of the proper motion is for a time when the companion was at position angle 204°.0, and at a distance 0″.30. The difference between the two values of the proper motion is due to orbital motion, but the present measures do not permit us to determine the relative masses of the components. Using Aitken's orbit, and the McCormick value of the parallax, the mass of the system is found to be 0.88 times that of the sun.

TABLE 1

PLATES OF LALANDE 25224

No.	Date.	Hour Angle.	Observers.	Weight.
995	1915 Mar. 3	-0^h6	M	0.7
996	Mar. 3	0.0	M	0.8
1089	Mar. 20	−0.4	M	0.8
2473	1916 Mar. 12	−0.6	A	0.8
2492	Mar. 16	−0.6	M	0.8
2514	Mar. 19	−0.1	A	1.0
2702	June 3	+0.3	M, A	1.0
2703	June 3	+0.7	A	1.0
2713	June 10	+0.5	A	0.9
2722	June 18	+0.4	M, L	0.8
2723	June 18	+0.8	M, L	0.7
3589	1917 Jan. 16	−0.3	L	0.7
3590	Jan. 16	+0.1	L	0.9
3651	Feb. 10	0.0	Ol	0.8
3652	Feb. 10	+0.4	Ol	0.7
3682	Feb. 20	−0.4	L	0.9
3683	Feb. 20	0.0	L	0.9
3923	May 1	−0.6	M	0.9
3924	May 1	−0.2	M	0.8
3983	May 19	+0.6	Ol	0.7
3984	May 19	+1.0	Ol	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−53.6	+21.4	+0.168
2	.12	−49.4	+10.6	.274
3	.15	+47.3	−22.9	.366
4	.13	+55.7	− 9.1	+0.192
Parallax star	0.21	+ 5.4	− 3.6	

TABLE 2

REDUCTIONS FOR LALANDE 25224

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
995	−0.0012	0.7	+0.631	−440	−0.0009	−0″.02
996	− .0022	0.8	+ .631	−440	+ .0001	.00
1089	− .0005	0.8	+ .410	−423	− .0020	− .04
2473	− .0078	0.8	+ .510	− 65	+ .0029	+ .05
2492	− .0065	0.8	+ .456	− 61	+ .0015	+ .03
2514	− .0051	1.0	+ .413	− 58	.0000	.00
2702	− .0062	1.0	− .695	+ 18	− .0007	− .01
2703	− .0090	1.0	− .695	+ 18	+ .0021	+ .04
2713	− .0062	0.9	− .766	+ 25	− .0008	− .02
2722	− .0071	0.8	− .833	+ 33	− .0001	.00
2723	− .0075	0.7	− .833	+ 33	+ .0003	+ .01
3589	− .0059	0.7	+ .916	+245	− .0008	− .01
3590	− .0067	0.9	+ .916	+245	.0000	.00
3651	− .0057	0.8	+ .824	+270	− .0012	− .02
3652	− .0055	0.7	+ .824	+270	− .0014	− .02
3682	− .0081	0.9	+ .742	+280	+ .0010	+ .02
3683	− .0076	0.9	+ .742	+280	+ .0005	+ .01
3923	− .0094	0.9	− .249	+350	+ .0006	+ .01
3924	− .0097	0.8	− .249	+350	+ .0010	+ .02
3983	− .0072	0.7	− .510	+368	− .0020	− .04
3984	−0.0080	0.9	−0.510	+368	−0.0012	−0.02

The normal equations are:

$$17.5c + 14.356\mu + 1.9293\pi = -0.1124 \text{ mm.}$$
$$+ 121.7546\mu - 0.9310\pi = -0.1734 \text{ mm.}$$
$$+ 7.6852\pi = -0.0020 \text{ mm.}$$

from which:

$c = -0.00597$ mm.

$\mu = -0.00071$ mm. $= -0''.0148$, or $-0''.054$ per year.

$\pi = +0.00116$ mm. $= +\mathbf{0''.024 \pm 0''.006}$.

Probable error of plate of unit weight

$$= \pm 0.00031 \text{ mm.} = \pm 0''.006.$$

LALANDE 25372 ($13^h\ 40^m$; $+15°\ 25'$)

This star of 8.7 magnitude and K type has a considerable proper motion 2″.31 per year. Mr. Olivier measured the plates and found a relative parallax + 0″.224 ± 0″.016 and a proper motion in right ascension + 1″.728 per year where the corresponding value from Porter is + 1″.780. The parallax has been several times determined as follows:

Parallax.	Authority.	Method.
+0″.43 ±0″.065	Flint	Meridian circle
+ .174± .043	Elkin	Heliometer
+ .221± .019	Russell	Photography
+ .152± .007	Schlesinger	Photography
+0.200	Adams	Spectrograph

TABLE 1

PLATES OF LALANDE 25372

No.	Date.	Hour Angle.	Observers.	Weight.
4029	1917 June 4	+0^h.3	Ol	1.0
4030	June 4	+0.7	Ol	0.9
4109	June 23	+0.7	M, B	0.9
4110	June 23	+1.1	M, B	0.9
5180	1918 Mar. 7	−0.3	Ol	0.7
5181	Mar. 7	+0.3	Ol	0.7
5221	Mar. 26	−0.2	A	0.9
5407	June 1	+0.5	L	0.9
5414	June 4	+0.6	L	1.0
5455	June 15	+0.6	Ol	1.0
6298	1919 Jan. 20	−0.5	H	1.0
6299	Jan. 20	+0.1	H	1.0
6414	Jan. 30	−1.1	D	1.0
6415	Jan. 30	−0.6	D	1.0
6693	Mar. 18	−0.9	D	0.7
7138	May 31	+0.6	Ol	1.0
7139	May 31	+1.0	Ol	0.8
7259	July 1	+1.5	.Ol	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−21.4	−27.0	+0.2915
2	.07	−24.7	− 4.2	.2519
3	.06	−16.0	+44.2	.1714
4	.14	+62.1	−13.0	+0.2852
Parallax star	0.14	+ 2.5	− 5.1	

TABLE 2

REDUCTIONS FOR LALANDE 25372

Plate.	Solution (*m*).	Weight (*p*).	Parallax Factor (*P*).	Time in Days (*t*).	Residual (*v*).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4029	−0.0798	1.0	−0.687	−407	−0.0018	−0″.04
4030	− .0780	0.9	− .687	−407	− .0036	− .07
4109	− .0806	0.9	− .857	−384	+ .0024	+ .05
4110	− .0817	0.9	− .857	−384	+ .0035	+ .07
5180	+ .0018	0.7	+ .601	−127	− .0059	− .10
5181	− .0024	0.7	+ .601	−127	− .0017	− .03
5221	− .0033	0.9	+ .343	− 98	+ .0031	+ .06
5407	− .0014	0.9	− .650	− 41	+ .0034	+ .07
5414	− .0003	1.0	− .684	− 38	+ .0027	+ .06
5455	+ .0070	1.0	− .793	− 27	− .0033	− .07
6298	+ .0738	1.0	+ .917	+192	− .0019	− .04
6299	+ .0752	1.0	+ .917	+192	− .0033	− .07
6414	+ .0680	1.0	+ .896	+202	+ .0060	+ .12
6415	+ .0728	1.0	+ .896	+202	+ .0012	+ .02
6693	+ .0784	0.7	+ .461	+249	+ .0016	+ .03
7138	+ .0880	1.0	− .636	+323	− .0030	− .06
7139	+ .0846	0.8	− .636	+323	+ .0004	+ .01
7259	+0.0898	1.0	−0.901	+354	−0.0006	−0.01

The normal equations are:

$$16.4c + 0.653\mu - 1.8569\pi = + 0.2961 \text{ mm.}$$
$$+ 112.6909\mu + 11.6363\pi = + 2.7015 \text{ mm.}$$
$$+ 9.2833\pi = + 0.3306 \text{ mm.}$$

from which:

$c = +0.01837$ mm.

$\mu = +0.02275$ mm. $= +0''.4733$, or $+1''.728$ per year.

$\pi = +0.01076$ mm. $= +\mathbf{0''.224 \pm 0''.016}$.

Probable error of plate of unit weight

$$\pm 0.00218 \text{ mm.} = \pm 0''.045.$$

μ VIRGINIS ($14^h\ 37^m$; $-5°\ 13'$)

This star is of 3.95 magnitude, of type F5, and of total proper motion $0''.339$. The only parallax published is the absolute value of Adams $0''.046$. Mr. Alden measured the plates and found a relative parallax $+0''.043 \pm 0''.010$, and a proper motion

TABLE 1

PLATES OF μ VIRGINIS

No.	Date.	Hour Angle.	Observers.	Weight.
982	1915 Mar. 2	-0^h8	G	0.6*
983	Mar. 2	−0.6	G	0.7
1030	Mar. 10	−0.4	G	0.8
1173	Apr. 11	−0.2	A	0.8
2714	June 17	−0.5	Ol	0.8
2715	June 17	+0.2	Ol	0.5*
3801	1917 Mar. 24	−0.6	Ol	0.7
3802	Mar. 24	−0.2	Ol	0.7
5021	1918 Feb. 6	+0.4	Ol	0.7
5088	Feb. 13	−0.6	Ds	0.8
5089	Feb. 13	−0.2	Ds	0.9
5106	Feb. 17	−0.8	Ds	0.8
5107	Feb. 17	−0.4	Ds	0.9
5432	June 8	+0.2	A	0.9
5433	June 8	+0.7	A	1.0
5451	June 11	−0.3	L	0.9
5454	June 12	+0.2	A	0.7*
5461	June 19	−0.3	A	1.0
5462	June 19	+0.2	A	1.0

* One exposure.

in right ascension + 0″.124, while the corresponding value from Boss is + 0″.106. The star was discovered to be a spectroscopic binary by Burns (*Lick Observatory Bulletin*, **199**, 1910).

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−86.5	+ 2.3	+0.2245
2	.19	−19.4	−53.5	.1848
3	.12	− 7.4	+29.4	.2133
4	.20	+55.4	+16.3	.1911
5	.16	+57.9	+ 5.5	+0.1863
Parallax star	0.16	− 3.2	+ 1.0	

TABLE 2

REDUCTIONS FOR μ VIRGINIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
982	+0.0051	0.6	+0.821	−794	−0.0019	−0″.03
983	+ .0019	0.7	+ .821	−794	+ .0013	+ .02
1030	+ .0028	0.8	+ .750	−786	+ .0004	+ .01
1173	+ .0012	0.8	+ .340	−754	+ .0017	+ .03
2714	+ .0089	0.8	− .676	−321	− .0010	− .02
2715	+ .0121	0.5	− .676	−321	− .0042	− .06
3801	+ .0136	0.7	+ .586	− 41	+ .0015	+ .03
3802	+ .0148	0.7	+ .586	− 41	+ .0003	+ .01
5021	+ .0243	0.7	+ .934	+278	− .0032	− .06
5088	+ .0242	0.8	+ .917	+285	− .0030	− .06
5089	+ .0198	0.9	+ .917	+285	+ .0014	+ .03
5106	+ .0186	0.8	+ .901	+289	+ .0026	+ .05
5107	+ .0218	0.9	+ .901	+289	− .0006	− .01
5432	+ .0215	0.9	− .559	+400	− .0015	− .03
5433	+ .0183	1.0	− .559	+400	+ .0017	+ .04
5451	+ .0234	0.9	− .597	+403	− .0034	− .07
5454	+ .0154	0.7	− .610	+404	+ .0046	+ .08
5461	+ .0196	1.0	− .694	+411	+ .0003	+ .01
5462	+0.0187	1.0	−0.694	+411	+0.0012	+0.02

The normal equations are:

$$15.2c + 6.590\mu + 2.2109\pi = + 0.2371 \text{ mm.}$$
$$+ 314.135\mu - 15.9131\pi = + 0.5793 \text{ mm.}$$
$$+ 8.0520\pi = + 0.0226 \text{ mm.}$$

from which:

$c = + 0.01459$ mm.
$\mu = + 0.00164$ mm. $= + 0''.0341$, or $+ 0''.125$ per year.
$\pi = + 0.00205$ mm. $= + \mathbf{0''.043 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.013 \text{ mm.} = \pm 0''.027.$$

ξ BOOTIS ($14^h\ 46^m$; $+19°\ 31'$)

This forms a well-known double Σ 1888, of magnitudes 4.7 and 6.6, and of types G6 and K3, respectively. Two orbits have been published, that of Lohse with a period of 159.54 years, and the other by Doberck with the period 179.60 years. The former represents in a better manner the recent observations of Aitken (*Publications Lick Observatory*, **12**, 95, 1914). Bottlinger (*Astronomische Nachrichten*, 4738), from a discussion of the proper motion finds that ξ Bootis is a member of the Ursa Major group, with a theoretical parallax of $+ 0''.044$. Adams by the spectrograph finds the parallax of $+ 0''.182$, while Allegheny by photography obtains $+ 0''.147 \pm 0''.007$. Mr. Olivier measured the McCormick series of plates. He finds the parallax of $+ 0''.200 \pm 0''.012$, with a proper motion in right ascension of $+ 0''.150$ per year. The value from Boss amounts to $+ 0''.130$. While the present series of plates were being taken, the motion of the companion was almost entirely in declination, so that this orbital motion would not affect the proper motion in right ascension. Apparently, the value of the parallax of ξ Bootis shows that it is not a member of the Ursa Major group. Using the McCormick value of the parallax, and the orbit of Lohse, the mass of the system of ξ Bootis is 0.56 that of the sun.

TABLE 1

PLATES OF ξ BOOTIS

No.	Date.	Hour Angle.	Observers.	Weight.
72	1914 June 13	+0h8	M	0.8
87	June 23	+0.3	M, Ol	0.6
95	June 24	0.0	M, Ol	0.7
845	1915 Feb. 6	−0.4	M	0.5
846	Feb. 6	+0.1	M	0.9
1007	Mar. 8	−0.9	M	0.5
1008	Mar. 8	−0.2	M	0.9
1020	Mar. 9	−0.9	M	0.8
1167	Apr. 8	−0.4	G	0.9
1179	Apr. 12	−0.2	M	0.9
1192	Apr. 13	−0.1	Ol	0.9
1341	June 6	+0.4	M	0.6
1350	June 9	0.0	G	1.0
1379	June 22	+0.2	M, A	0.8
1380	June 22	+0.8	A	1.0
2376	1916 Feb. 3	+0.4	A	0.7
2413	Feb. 19	−0.1	M	0.6
2414	Feb. 19	+0.3	M	0.8
2504	Mar. 17	−0.2	G	0.8
4099	1917 June 22	+0.3	Ol, B	0.7
4100	June 22	+0.4	Ol, B	0.7
4125	June 29	−0.2	Ol, B	0.9
4126	June 29	+0.2	Ol, B	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−80.3	+34.2	+0.1113
2	.14	+25.7	+ 3.4	.2217
3	.16	+28.4	−11.1	.2940
4	.12	+26.2	−26.5	+0.3730
Parallax star	0.17	+14.9	− 8.6	

TABLE 2

REDUCTIONS FOR ξ BOOTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
72	−0.0211	0.8	−0.598	−460	+0.0006	+0″.01
87	− .0193	0.6	− .717	−450	− .0022	− .04
95	− .0209	0.7	− .727	−449	− .0006	− .01
845	+ .0004	0.5	+ .940	−222	− .0014	− .02
846	− .0019	0.9	+ .940	−222	+ .0009	+ .02
1007	− .0011	0.5	+ .790	−192	− .0008	− .01
1008	− .0060	0.9	+ .790	−192	+ .0041	+ .08
1020	− .0013	0.8	+ .782	−191	− .0006	− .01
1167	− .0014	0.9	+ .417	−161	− .0034	− .07
1179	− .0016	0.9	+ .358	−157	− .0037	− .07
1192	− .0004	0.9	+ .342	−156	− .0051	− .10
1341	− .0128	0.6	− .501	−102	+ .0003	.00
1350	− .0180	1.0	− .542	− 99	+ .0052	+ .11
1379	− .0161	0.8	− .703	− 86	+ .0020	+ .04
1380	− .0150	1.0	− .703	− 86	+ .0008	+ .02
2376	+ .0048	0.7	+ .941	+140	+ .0013	+ .02
2413	+ .0069	0.6	+ .906	+156	− .0008	− .01
2414	+ .0043	0.8	+ .906	+156	+ .0018	+ .03
2504	+ .0017	0.8	+ .692	+183	+ .0029	+ .05
4099	+ .0039	0.7	− .708	+645	− .0037	− .06
4100	− .0012	0.7	− .708	+645	+ .0014	+ .02
4125	.0000	0.9	− .780	+652	− .0003	− .01
4126	+ .0005	0.9	−0.780	+652	−0.0008	−0.02

The normal equations are:

$$17.9c + 1.131\mu + 0.6129\pi = -0.0936 \text{ mm.}$$
$$+ 210.0668\mu - 11.1106\pi = +0.3008 \text{ mm.}$$
$$+ 9.2246\pi = +0.0634 \text{ mm.}$$

from which:

$c = -0.00568$ mm.

$\mu = +0.00197$ mm. $= +0''.0410$, or $+0''.150$ per year.

$\pi = +0.00963$ mm. $= +$ **0″.200 ± 0″.012.**

Probable error of plate of unit weight

$$\pm 0.00165 \text{ mm.} = \pm 0''.034.$$

β 31 ($14^h\ 48^m$; $+19°\ 8'$)

This double was discovered by Burnham with the six-inch. The magnitudes are 8.5 and 10.2, and they are separated by a distance of 1″.5. The pair has a total proper motion of 0″.230 in position angle 350°, which motion is shared by a third star of 12.5 magnitude at a distance of 9″.4. These stars thus form a triple system. Mr. Olivier measured the McCormick series of plates and finds a proper motion in right ascension of + 0″.007, while the value due to Porter is − 0″.022.

TABLE 1

PLATES OF β 31

No.	Date.	Hour Angle.	Observers.	Weight.
96	1914 June 24	+1h3	M, Ol	0.8
97	June 24	+1.8	M, Ol	0.7
108	June 30	+1.0	M, Ol	1.0
110	July 3	+0.5	M, Ol	0.9
904	1915 Feb. 18	+0.6	G	1.0
905	Feb. 18	+1.1	G	0.6
942	Feb. 22	−1.7	G	0.4
943	Feb. 22	−1.1	G	0.8
1131	Mar. 30	+0.7	Ol	0.7
1144	Apr. 3	−0.6	M	0.7
1360	June 10	+0.6	Ol	0.8
1361	June 10	+1.2	Ol	0.7
1385	June 23	+0.8	G	0.7
3705	1917 Feb. 24	−0.4	Ol	0.9
3706	Feb. 24	−0.1	Ol	0.6
3711	Mar. 5	+0.1	Ol	0.7
3763	Mar. 15	−1.0	M	0.8
3764	Mar. 15	−0.5	M	0.9
3993	May 23	−0.1	Ol	0.6
3994	May 23	+0.4	Ol	0.8
3995	May 23	+0.8	Ol	0.9
4018	May 28	+0.6	Ol	1.2*
4019	May 28	+1.0	Ol	0.8
4160	July 3	+0.2	Ol	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.23	−49.6	+14.3	+0.2452
2	.11	−33.3	−45.1	.2434
3	.10	+36.6	+33.9	.2563
4	.10	+46.3	− 3.1	+0.2551
Parallax star	0.19	+ 0.9	+ 0.4	

TABLE 2

REDUCTIONS FOR β 31

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
96	+0.0141	0.8	−0.723	−582	−0.0002	0″.00
97	+ .0128	0.7	− .723	−582	+ .0011	+ .02
108	+ .0147	1.0	− .784	−576	− .0008	− .02
110	+ .0157	0.9	− .811	−573	− .0018	− .04
904	+ .0105	1.0	+ .912	−343	+ .0038	+ .08
905	+ .0134	0.6	+ .912	−343	+ .0009	+ .01
942	+ .0112	0.4	+ .894	−339	+ .0031	+ .04
943	+ .0150	0.8	+ .894	−339	− .0007	− .01
1131	+ .0174	0.7	+ .524	−303	− .0031	− .05
1144	+ .0191	0.7	+ .495	−299	− .0048	− .08
1360	+ .0133	0.8	− .550	−231	+ .0010	+ .02
1361	+ .0121	0.7	− .550	−231	+ .0022	+ .04
1385	+ .0134	0.7	− .709	−218	+ .0009	+ .01
3705	+ .0157	0.9	+ .880	+394	− .0007	− .01
3706	+ .0136	0.6	+ .880	+394	+ .0014	+ .02
3711	+ .0141	0.7	+ .816	+403	+ .0009	+ .02
3763	+ .0170	0.8	+ .722	+413	− .0020	− .04
3764	+ .0148	0.9	+ .722	+413	+ .0002	.00
3993	+ .0133	0.6	− .296	+482	+ .0017	+ .03
3994	+ .0201	0.8	− .296	+482	− .0051	− .10
3995	+ .0168	0.9	− .296	+482	− .0018	− .04
4018	+ .0137	1.2	− .373	+487	+ .0013	+ .03
4019	+ .0143	0.8	− .373	+487	+ .0007	+ .01
4160	+0.0126	1.0	−0.814	+523	+0.0024	+0.05

The normal equations are:

$$19.0c + 3.400\mu + 0.2034\pi = + 0.2769 \text{ mm.}$$
$$+ 362.0377\mu + 8.6086\pi = + 0.0849 \text{ mm.}$$
$$+ 9.1062\pi = + 0.0047 \text{ mm.}$$

from which:

$c = + 0.01455$ mm.

$\mu = + 0.00010$ mm. $= + 0''.0020$, or $+ 0''.007$ per year.

$\pi = + 0.00010$ mm. $= \mathbf{+ 0''.002 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

LALANDE 27173 ($14^h\ 51^m$; $-20°\ 57'$)

This is a pair of the 61 Cygni type. According to Boss, the brighter star has a total motion of $1''.92$ per year in position angle $150°\ 17'$, while the fainter has a greater motion of $2''.04$ in position angle $149°\ 31'$. The brighter is of 5.8 magnitude and K5 type, and the fainter of 8.7 magnitude, and Ma type. De Sitter, by the heliometer finds the parallax of the brighter to be $+ 0''.162 \pm 0''.011$, and for the fainter, $+ 0''.173 \pm 0''.012$. Flint with the meridian circle finds the value for the brighter of $+ 0''.04 \pm 0''.065$. Adams by means of the spectrograph finds the parallaxes of $+ 0''.200$ and $+ 0''.190$ for brighter and fainter, respectively. It was a very difficult task to obtain a satisfactory series of photographs for the present discussion. The plates at the two epochs were taken in midsummer and during February and March, and with the great southern declination, the seeing was generally none too good. In addition, the region required a relatively long exposure due to the faintness of the comparison stars. The plates were measured by Mr. Mitchell. Apparently, the two stars form a physical system. The McCormick value of the parallax of the system amounts to:

$$\mathbf{+ 0''.189 \pm 0''.006}.$$

TABLE 1

PLATES OF LALANDE 27173

No.	Date.	Hour Angle.	Observers.	Weight.
128	1914 July 12	+1^{h}9	M	0.5*
133	July 18	+1.0	M	0.5
139	July 19	+1.2	M	1.0
917	1915 Feb. 19	−0.4	M	0.7
930	Feb. 20	−1.2	G	0.5*
931	Feb. 20	−0.5	G	1.0
970	Mar. 1	−0.5	M	1.0
971	Mar. 1	+0.1	M	0.9
998	Mar. 3	+0.2	M	0.9
1359	June 10	−0.2	Ol	1.0
1477	July 17	+1.4	A	0.7
1488	July 18	+1.5	G	0.7
2466	1916 Mar. 11	0.0	M	0.8
2548	Apr. 4	−0.2	M	0.8
2560	Apr. 6	+0.1	A	1.0
2724	June 18	+0.2	M, L	0.8
2725	June 18	+0.8	M, L	0.8
2770	June 25	+0.2	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−51.7	+25.4	+0.222
2	.16	−48.3	− 0.6	.191
3	.12	+ 0.9	+13.5	.217
4	.12	+46.9	+ 3.9	.213
5	.18	+52.2	−42.2	+0.157
Brighter star	.25	− 2.0	+ 2.5	
Fainter star	0.10	− 2.8	+ 2.9	

TABLE 2

REDUCTIONS FOR LALANDE 27173, BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
917	+0.0200	0.7	+0.914	−202	−0.0016	−0″.03
930	+ .0234	0.5	+ .910	−201	− .0049	− .07
931	+ .0194	1.0	+ .910	−201	− .0009	− .02
970	+ .0185	1.0	+ .859	−192	+ .0007	+ .01
971	+ .0172	0.9	+ .859	−192	+ .0020	+ .04
998	+ .0188	0.9	+ .848	−190	+ .0006	+ .02
1359	+ .0211	1.0	− .536	− 91	− .0002	.00
1477	+ .0219	0.7	− .906	− 54	+ .0008	+ .01
1488	+ .0214	0.7	− .912	− 53	+ .0014	+ .02
2466	+ .0679	0.8	+ .772	+184	− .0001	.00
2548	+ .0656	0.8	+ .486	+208	+ .0030	+ .05
2560	+ .0686	1.0	+ .458	+210	.0000	.00
2724	+ .0708	0.8	− .648	+283	− .0018	− .03
2725	+ .0684	0.8	− .648	+283	+ .0006	+ .01
2770	+0.0706	1.0	−0.729	+290	−0.0013	−0.03

The normal equations are:

$$12.6c + 1.218\mu + 2.2901\pi = + 0.5048 \text{ mm.}$$
$$+ 52.2023\mu - 9.5925\pi = + 0.6495 \text{ mm.}$$
$$+ 7.3990\pi = + 0.0210 \text{ mm.}$$

from which:

$c = + 0.03729$ mm.

$\mu = + 0.01309$ mm. $= + 0''.2724$, or $+ 0''.994$ per year.

$\pi = + 0.00827$ mm. $= + \mathbf{0''.172 \pm 0''.010.}$

Probable error of plate of unit weight

$$\pm 0.00112 \text{ mm.} = \pm 0''.023.$$

TABLE 3

REDUCTIONS FOR LALANDE 27173, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
128	−0.0447	0.5	−0.876	−222	−0.0013	−0″.02
133	− .0474	0.5	− .913	−216	+ .0017	+ .02
139	− .0456	1.0	− .918	−215	− .0001	.00
917	− .0049	0.7	+ .914	0	+ .0004	+ .01
930	− .0054	0.5	+ .910	+ 1	+ .0010	+ .01
931	− .0024	1.0	+ .910	+ 1	− .0020	− .04
970	− .0038	1.0	+ .859	+ 10	− .0002	.00
971	− .0043	1.0	+ .859	+ 10	+ .0003	+ .01
998	− .0051	0.9	+ .848	+ 12	+ .0012	+ .02
1359	− .0070	1.0	− .536	+111	.0000	.00
1477	− .0064	0.5	− .906	+148	− .0003	.00
1488	−0.0067	0.7	−0.912	+149	0.0000	0.00

The normal equations are:

$$9.3c - 1.124\mu + 1.0461\pi = -0.1278 \text{ mm.}$$
$$+ 13.3340\mu + 1.9925\pi = +0.1779 \text{ mm.}$$
$$+ 6.8730\pi = +0.0754 \text{ mm.}$$

from which:

$c = -0.01355$ mm.

$\mu = +0.01072$ mm. $= +0''.2226$, or $+0''.812$ per year.

$\pi = +0.00992$ mm. $= +\mathbf{0''.206 \pm 0''.005}$.

Probable error of plate of unit weight

$$\pm 0.00065 \text{ mm.} = \pm 0''.012.$$

β BOOTIS ($14^h\ 58^m$; $+40°\ 47'$)

The only published values of the parallax of this star of small proper motion, of G5 type, and of magnitude 3.63 are the spectroscopic result of Adams giving an absolute parallax of $+0''.018$, and the relative value of Allegheny by photography $+0''.013 \pm 0''.008$. Mr. Alden measured the McCormick plates and found the relative parallax of $+0''.054 \pm 0''.015$, with a proper motion

in right ascension of $-0''.026$, while the corresponding value from Boss is $-0''.046$.

TABLE 1

PLATES OF β BOOTIS

No.	Date.	Hour Angle.	Observers.	Weight.
1021	1915 Mar. 9	$-0^h.4$	M	1.0
1043	Mar. 12	−0.8	G	1.0
1139	Mar. 31	−0.2	A	1.0
1147	Apr. 4	−0.5	A	0.9
2515	1916 Mar. 19	−0.4	A	1.0
2516	Mar. 19	−0.1	A	1.0
2530	Mar. 30	−0.3	A	0.8
2531	Mar. 30	0.0	A	0.7
2751	June 22	−0.6	Ol, L	0.8
2752	June 22	−0.2	Ol, L	0.8
2759	June 23	−0.6	M, L	1.0
2769	June 25	−0.5	M	0.9
3776	1917 Mar. 19	−0.4	A	0.9
3777	Mar. 19	0.0	A	0.9
3784	Mar. 21	−0.6	L	0.9
3785	Mar. 21	−0.2	L	0.9
4060	June 13	−0.3	A	1.0
4061	June 13	0.0	A	0.7*
4120	June 24	−0.3	A	0.9
4139	June 30	−0.3	M	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.26	−32.2	−53.5	+0.2097
2	.08	−21.9	+19.4	.2037
3	.18	− 0.8	+35.8	.1983
4	.09	+26.5	+36.6	.1924
5	.15	+28.4	−38.3	+0.1959
Parallax star	0.16	− 0.7	− 0.6	

TABLE 2

REDUCTIONS FOR β BOOTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1021	+0.0053	1.0	+0.812	−488	−0.0022	−0″.05
1043	+ .0042	1.0	+ .786	−485	− .0012	− .02
1139	+ .0046	1.0	+ .573	−466	− .0022	− .05
1147	− .0018	0.9	+ .520	−462	+ .0040	+ .08
2515	− .0018	1.0	+ .708	−112	+ .0033	+ .07
2516	+ .0044	1.0	+ .708	−112	− .0029	− .06
2530	− .0009	0.8	+ .576	−101	+ .0020	+ .04
2531	− .0014	0.7	+ .576	−101	+ .0025	+ .04
2751	− .0014	0.8	− .678	− 17	− .0010	− .02
2752	− .0025	0.8	− .678	− 17	+ .0001	.00
2759	− .0001	1.0	− .689	− 16	− .0024	− .05
2769	− .0066	0.9	− .712	− 14	+ .0041	+ .08
3776	− .0020	0.9	+ .711	+253	+ .0022	+ .04
3777	− .0011	0.9	+ .711	+253	+ .0013	+ .03
3784	+ .0022	0.9	+ .689	+255	− .0020	− .04
3785	+ .0028	0.9	+ .689	+255	− .0026	− .05
4060	− .0059	1.0	− .562	+339	+ .0025	+ .05
4061	− .0027	0.7	− .562	+339	− .0007	− .01
4120	+ .0009	0.9	− .698	+350	− .0047	− .09
4139	−0.0053	0.7	−0.762	+356	+0.0014	+0.02

The normal equations are:

$$17.8c - 2.312\mu + 2.9074\pi = -0.0048 \text{ mm.}$$
$$+ 155.0501\mu - 15.6172\pi = -0.0924 \text{ mm.}$$
$$+ 8.1618\pi = +0.0244 \text{ mm.}$$

from which:

$c = -0.00074$ mm.

$\mu = -0.00035$ mm. $= -0''.0072$, or $-0''.026$ per year.

$\pi = +0.00259$ mm. $= +\mathbf{0''.054 \pm 0''.015}$.

Probable error of plate of unit weight

$$\pm 0.00177 \text{ mm.} = \pm 0''.037.$$

μ BOOTIS ($15^h\ 20^m$; $+37°\ 43'$)

This is a triple system with common proper motion. The brightest star, A, is of magnitude 4.47, and of type F. μ^2 = BC

TABLE 1

PLATES OF μ BOOTIS

No.	Date.	Hour Angle.	Observers.	Weight.
958	1915 Feb. 26	-0^h6	M	0.5
1009	Mar. 8	−0.2	M	0.6
1031	Mar. 10	−0.8	G	0.9
1032	Mar. 10	−0.4	G	0.8
3724	1917 Mar. 6	−0.6	L	0.9
3725	Mar. 6	−0.2	L	0.8
3816	Mar. 25	−0.5	L	0.9
3817	Mar. 25	−0.1	L	0.9
3853	Apr. 7	−0.8	L	1.0
3854	Apr. 7	−0.5	L	0.9
4111	June 23	−0.1	M, B	1.0
4140	June 30	−0.2	M	0.8
5123	1918 Feb. 22	−0.6	A	1.0
5124	Feb. 22	−0.2	A	1.0
5139	Feb. 26	−1.4	A	0.8
5140	Feb. 26	−0.9	A	0.9
5498	July 2	−0.3	A	1.0
5499	July 2	0.0	A	0.7*
5522	July 4	−0.2	A	1.0
5526	July 6	−0.1	A	0.8
6396	1919 Jan. 29	−0.5	M	0.9
6418	Jan. 30	−0.7	D	0.8*
6419	Jan. 30	−0.3	D	0.8*
6539	Feb. 17	−0.7	D	1.0
6540	Feb. 17	−0.2	D	1.0
7269	July 2	−0.5	F	0.9
7270	July 2	−0.1	F	0.7*
7283	July 5	−0.1	H	1.0
7300	July 11	+0.1	H	0.6*

* One exposure.

is a double of long period, about 250 years, and with an angular separation of 1″, with a combined magnitude 6.66 and spectral type K. For BC, Flint has determined a relative parallax of + 0″.030 ± 0″.026. By photography at Swarthmore, the relative parallax of the star A was found to be + 0″.033 ± 0″.013, while BC gave the result + 0″.054 ± 0″.011. Miss Darkow measured the McCormick plates and found for A and BC the parallaxes of + 0″.049 ± 0″.008, and + 0″.031 ± 0″.009, respectively, with proper motions in right ascension − 0″.112 and − 0″.146, respectively, while the corresponding values from Boss are − 0″.149 and − 0″.145. By the spectroscopic method, Adams found the absolute parallax of A and BC to be + 0″.035 and + 0″.040.

The McCormick measures give for the parallax of the system the value + **0″.040 ± 0″.006.**

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				A.	BC.
	mm.	mm.	mm.		
1	0.09	−44.6	−25.7	+0.337	+0.347
2	.14	+ 0.9	+45.0	.162	.108
3	.10	+17.3	+18.3	.200	.186
4	.15	+26.4	−37.6	.301	.359
A	.17	− 3.50	− 9.03		
BC	0.10	− 2.71	−14.19		

The normal equations are:

$$24.0c + 22.800\mu + 8.4217\pi = -0.5826 \text{ mm.}$$
$$+ 521.2848\mu - 18.5075\pi = -1.3557 \text{ mm.}$$
$$+ 16.1833\pi = -0.1343 \text{ mm.}$$

from which:

$c = -0.02369$ mm.

$\mu = -0.00148$ mm. $= -0''.0308$, or $-0''.112$ per year.

$\pi = +0.00234$ mm. $= +$ **0″.049 ± 0″.008.**

Probable error of plate of unit weight

± 0.00128 mm. $= \pm 0''.027$.

TABLE 2

REDUCTIONS FOR μ BOOTIS A

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
958	−0.0054	0.5	+0.926	−910	−0.0026	−0″.04
1009	− .0080	0.6	+ .871	−900	− .0003	− .01
1031	− .0071	0.9	+ .857	−898	− .0013	− .02
1032	− .0089	0.8	+ .857	−898	+ .0005	+ .01
3724	− .0203	0.9	+ .881	−171	+ .0012	+ .02
3725	− .0198	0.8	+ .881	−171	+ .0007	+ .01
3816	− .0215	0.9	+ .714	−152	+ .0017	+ .03
3817	− .0222	0.9	+ .714	−152	+ .0024	+ .05
3853	− .0223	1.0	+ .554	−139	+ .0020	+ .04
3854	− .0170	0.9	+ .554	−139	− .0033	− .07
4111	− .0224	1.0	− .622	− 62	− .0018	− .04
4140	− .0257	0.8	− .706	− 55	+ .0012	+ .02
5123	− .0259	1.0	+ .939	+182	+ .0017	+ .04
5124	− .0256	1.0	+ .939	+182	+ .0014	+ .03
5139	− .0205	0.8	+ .924	+186	− .0038	− .07
5140	− .0235	0.9	+ .924	+186	− .0008	− .01
5498	− .0334	1.0	− .726	+312	+ .0034	+ .07
5499	− .0266	0.7	− .726	+312	− .0034	− .06
5522	− .0308	1.0	− .747	+314	+ .0007	+ .01
5526	− .0312	0.8	− .768	+316	+ .0010	+ .02
6396	− .0293	0.9	+ .928	+523	.0000	.00
6418	− .0321	0.8	+ .931	+524	+ .0028	+ .05
6419	− .0304	0.8	+ .931	+524	+ .0011	+ .02
6539	− .0278	1.0	+ .951	+542	− .0017	− .04
6540	− .0269	1.0	+ .951	+542	− .0026	− .05
7270	− .0341	0.7	− .723	+677	− .0013	− .02
7283	− .0344	1.0	− .755	+680	− .0011	− .02
7300	−0.0357	0.6	−0.814	+686	0.0000	0.00

TABLE 3

REDUCTIONS FOR μ BOOTIS BC

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
958	−0.0062	0.5	+0.926	−910	−0.0013	−0″.02
1009	− .0126	0.6	+ .871	−900	+ .0048	+ .08
1031	− .0070	0.9	+ .857	−898	− .0009	− .02
1032	− .0100	0.8	+ .857	−898	+ .0021	+ .04
3724	− .0214	0.9	+ .881	−171	− .0004	− .01
3725	− .0225	0.8	+ .881	−171	+ .0008	+ .01
3816	− .0202	0.9	+ .714	−152	− .0022	− .04
3817	− .0184	0.9	+ .714	−152	− .0040	− .08
3853	− .0197	1.0	+ .554	−139	− .0032	− .07
3854	− .0208	0.9	+ .554	−139	− .0021	− .04
4111	− .0266	1.0	− .622	− 62	+ .0005	+ .01
4140	− .0286	0.8	− .706	− 55	+ .0022	+ .04
5123	− .0284	1.0	+ .939	+182	.0000	.00
5139	− .0297	0.8	+ .924	+186	+ .0012	+ .02
5140	− .0292	0.9	+ .924	+186	+ .0007	+ .01
5498	− .0351	1.0	− .726	+312	+ .0017	+ .04
5499	− .0303	0.7	− .726	+312	− .0031	− .05
5522	− .0355	1.0	− .747	+314	+ .0020	+ .04
5526	− .0333	0.8	− .768	+316	− .0002	.00
6396	− .0396	0.9	+ .928	+523	+ .0046	+ .09
6418	− .0356	0.8	+ .931	+524	+ .0006	+ .01
6419	− .0342	0.8	+ .931	+524	− .0008	− .01
6539	− .0372	1.0	+ .951	+542	+ .0019	+ .04
6540	− .0334	1.0	+ .951	+542	− .0019	− .04
7269	− .0395	0.9	− .723	+677	− .0009	− .02
7270	− .0387	1.0	− .723	+677	− .0017	− .04
7283	− .0393	1.0	− .755	+680	− .0012	− .02
7300	−0.0443	0.5	−0.814	+686	+0.0036	+0.05

The normal equations are:

$$24.1c + 28.418\mu + 6.6965\pi = -0.6795 \text{ mm.}$$
$$+ 568.2659\mu - 25.5317\pi = -1.8760 \text{ mm.}$$
$$+ 15.8626\pi = -0.1038 \text{ mm.}$$

from which:

$c = -0.02635$ mm.
$\mu = -0.00192$ mm. $= -0''.0399$, or $-0''.146$ per year.
$\pi = +0.00150$ mm. $= +\mathbf{0''.031 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00142 \text{ mm.} = \pm 0''.030.$$

α CORONÆ BOREALIS ($15^h\ 30^m$; $+27°\ 3'$)

The brightest star in the Northern Crown is of A type, of magnitude 2.31, and of total proper motion $0''.157$. The older values of the parallax are two values by Pritchard by photography with the average $-0''.038$, and the meridian circle result of Flint $+0''.054 \pm 0''.029$. According to Bottlinger, (*A. N.* 4738) this star is a member of an extended Ursa Major group and should have a parallax $+0''.041$. Mr. Olivier measured the plates and determined a relative parallax $+0''.056 \pm 0''.010$ and a proper motion in right ascension $+0''.114$ where the corresponding value from Boss is $+0''.120$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−53.4	+39.8	+0.2229
2	.28	−18.0	−35.8	.2057
3	.23	+ 5.7	+33.6	.2800
4	.15	+65.7	−37.6	+0.2914
Parallax star	0.24	+ 5.2	− 0.1	

TABLE 1

PLATES OF α CORONÆ BOREALIS

No.	Date.	Hour Angle.	Observers.	Weight.
1083	1915 Mar. 18	-1^h1	M	0.7
1101	Mar. 22	−0.9	G	1.0
1219	Apr. 17	−0.6	M	0.8
1235	Apr. 23	−0.3	Ol	0.9
2485	1916 Mar. 15	−0.7	Ol	0.8
2735	June 19	−0.2	Ol, L	0.8
2741	June 21	−0.9	M, L	0.9
2742	June 22	−0.3	M, L	0.9
2774	June 26	−0.9	Ol	0.6*
3664	1917 Feb. 12	−0.2	Ol	0.8
3803	Mar. 24	−0.4	Ol	0.6
3804	Mar. 24	0.0	Ol	0.8
3834	Mar. 31	−0.8	Ol	0.7
3835	Mar. 31	−0.3	Ol	0.8
5031	1918 Feb. 7	−1.0	Ol	0.8
5032	Feb. 7	−0.4	Ol	0.8
5059	Feb. 10	−0.2	Ol	0.8
5183	Mar. 7	−0.4	Ol	0.9
5239	Mar. 28	−0.4	Ol	0.6*
5488	June 28	−0.6	Ol	1.0
5531	July 8	−0.2	A	1.0
6459	1919 Feb. 4	−0.7	H	1.0
6460	Feb. 4	−0.2	H	1.0
6526	Feb. 16	−0.8	M	0.8
6527	Feb. 16	−0.4	M	1.0
6595	Feb. 27	−0.3	H	1.0
6702	Mar. 20	−1.2	D	1.0
6703	Mar. 20	−0.9	D	0.9
7295	July 7	−0.3	D	1.0
7296	July 8	−0.3	Ol	0.8
7301	July 11	+0.2	H	0.7
7311	July 14	0.0	H	0.7

* One exposure.

TABLE 2

REDUCTIONS FOR α CORONÆ BOREALIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1083	+0.0282	0.7	+0.815	−940	−0.0039	−0″.07
1101	+ .0248	1.0	+ .778	−936	− .0006	− .01
1219	+ .0284	0.8	+ .457	−910	− .0046	− .09
1235	+ .0236	0.9	+ .368	−904	.0000	.00
2485	+ .0308	0.8	+ .834	−577	− .0010	− .02
2735	+ .0250	0.8	− .541	−481	+ .0025	+ .05
2741	+ .0248	0.9	− .568	−479	+ .0026	+ .05
2742	+ .0229	0.9	− .568	−479	+ .0045	+ .09
2774	+ .0300	0.6	− .633	−474	− .0026	− .04
3664	+ .0356	0.8	+ .958	−243	− .0005	− .01
3803	+ .0304	0.6	+ .752	−203	+ .0047	+ .08
3804	+ .0326	0.8	+ .752	−203	+ .0025	+ .05
3834	+ .0368	0.7	+ .675	−196	− .0018	− .03
3835	+ .0317	0.8	+ .675	−196	+ .0033	+ .06
5031	+ .0403	0.8	+ .952	+117	+ .0001	.00
5032	+ .0431	0.8	+ .952	+117	− .0027	− .05
5059	+ .0453	0.8	+ .957	+120	− .0048	− .09
5183	+ .0396	0.9	+ .894	+145	+ .0011	+ .02
5239	+ .0397	0.6	+ .712	+166	+ .0008	+ .01
5488	+ .0359	1.0	− .652	+258	+ .0023	+ .05
5531	+ .0379	1.0	− .766	+268	+ .0002	.00
6459	+ .0452	1.0	+ .944	+479	+ .0006	+ .01
6460	+ .0454	1.0	+ .944	+479	+ .0004	+ .01
6526	+ .0474	0.8	+ .958	+491	− .0014	− .02
6527	+ .0420	1.0	+ .958	+491	+ .0040	+ .08
6595	+ .0432	1.0	+ .934	+502	+ .0029	+ .06
6702	+ .0476	1.0	+ .797	+523	− .0015	− .03
6703	+ .0471	0.9	+ .797	+523	− .0010	− .02
7295	+ .0468	1.0	− .753	+632	− .0033	− .07
7296	+ .0456	0.8	− .763	+633	− .0021	− .04
7301	+ .0429	0.7	− .793	+636	+ .0006	+ .01
7311	+0.0479	0.7	−0.822	+639	−0.0044	−0.08

The normal equations are:

$$26.9c + 5.065\mu + 9.3786\pi = + 1.0048 \text{ mm.}$$
$$+ 721.5128\mu - 4.8898\pi = + 1.2477 \text{ mm.}$$
$$+ 16.8578\pi = + 0.3769 \text{ mm.}$$

from which:

$c = + 0.03613$ mm.
$\mu = + 0.00149$ mm. $= + 0''.0311$, or $+ 0''.114$ per year.
$\pi = + 0.00269$ mm. $= + \mathbf{0''.056 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00169 \text{ mm.} = \pm 0''.035.$$

α SERPENTIS ($15^h\ 39^m$; $+6°\ 44'$)

Two values of the parallax of this star, of 2.75 magnitude, and Ko type have been published. Flint's result from meridian circle is $+ 0''.151 \pm 0''.034$, while the spectroscopic value of Adams is $+ 0''.019$. The proper motion is small, and amounts to $0''.14$ per year. Mr. Mitchell measured the McCormick plates and derived the parallax of $+ 0''.038 \pm 0''.008$, with a proper motion in right ascension of $+ 0''.129$ while the value from Boss is $+ 0''.135$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.28	−56.1	+55.7	+0.367
2	.20	+ 3.7	−41.9	.261
3	.20	+52.4	−13.8	+0.372
Parallax star	0.23	− 0.1	+ 4.4	

TABLE 1

PLATES OF α SERPENTIS

No.	Date.	Hour Angle.	Observers.	Weight.
111	1914 July 3	+1h0	M	0.6*
112	July 5	+0.5	M	0.8
154	July 22	+1.0	M	0.7
919	1915 Feb. 19	+0.2	M	0.8
1022	Mar. 9	−0.4	M	0.7
1023	Mar. 9	+0.1	M	0.7
1092	Mar. 20	−0.7	M	0.7
1158	Apr. 7	−0.7	A	0.7
1168	Apr. 8	−0.6	G	0.8
1180	Apr. 12	−0.6	M	1.0
1381	June 22	+0.4	A	0.7
1382	June 22	+0.9	A	0.8
1389	June 25	+1.0	G	0.5*
1390	June 25	+1.4	G	0.8
3685	1917 Feb. 20	−0.8	L	0.9
3686	Feb. 20	−0.4	L	1.0
3695	Feb. 22	−0.9	M	0.9
3696	Feb. 22	−0.5	M	0.7
3786	Mar. 21	−0.3	L	0.9
4149	July 1	−0.6	M	0.9
4150	July 1	−0.3	M	0.9
4209	July 31	+1.0	A	0.8

* One exposure.

The normal equations are:

$$17.3c + 3.402\mu + 3.0693\pi = + 0.2348 \text{ mm.}$$
$$+ 275.2416\mu + 6.5515\pi = + 0.5234 \text{ mm.}$$
$$+ 10.6397\pi = + 0.0702 \text{ mm.}$$

from which:

$c = + 0.01292$ mm.

$\mu = + 0.00170$ mm. $= + 0''.0353$, or $+ 0''.129$ per year.

$\pi = + 0.00183$ mm. $= + \mathbf{0''.038 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00127 \text{ mm.} = \pm 0''.026.$$

TABLE 2

REDUCTIONS FOR α SERPENTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
111	+0.0050	0.6	−0.687	−533	−0.0024	−0″.04
112	+ .0021	0.8	− .710	−531	+ .0005	+ .01
154	+ .0033	0.7	− .873	−514	− .0007	− .01
919	+ .0090	0.8	+ .961	−302	+ .0005	+ .01
1022	+ .0080	0.7	+ .901	−284	+ .0017	+ .03
1023	+ .0098	0.7	+ .901	−284	− .0001	.00
1092	+ .0080	0.7	+ .820	−273	+ .0018	+ .03
1158	+ .0123	0.7	+ .628	−255	− .0026	− .04
1168	+ .0068	0.8	+ .614	−254	+ .0029	+ .05
1180	+ .0068	1.0	+ .561	−250	+ .0029	+ .06
1381	+ .0073	0.7	− .542	−179	+ .0016	+ .03
1382	+ .0106	0.8	− .542	−179	− .0017	− .03
1389	+ .0130	0.5	− .583	−176	− .0041	− .06
1390	+ .0108	0.8	− .583	−176	− .0019	− .04
3685	+ .0236	0.9	+ .960	+430	− .0016	− .03
3686	+ .0208	1.0	+ .960	+430	+ .0012	+ .02
3695	+ .0238	0.9	+ .957	+432	− .0018	− .04
3696	+ .0242	0.7	+ .957	+432	− .0022	− .04
3786	+ .0238	0.9	+ .807	+459	− .0016	− .03
4149	+ .0192	0.9	− .666	+561	+ .0020	+ .04
4150	+ .0215	0.9	− .666	+561	− .0003	− .01
4209	+0.0182	0.8	− .934	+591	+0.0030	+0.06

β SERPENTIS ($15^h\ 41^m$; $+15°\ 44'$)

This star of magnitude 3.74, and type A2 has a proper motion of 0″.09. According to Bottlinger (*Astronomische Nachrichten*, **4738**) it forms a member of the Ursa Major group, with a theoretical parallax of + 0″.023. Allegheny finds the parallax + 0″.031 ± 0″.008. Mr. Mitchell measured the McCormick plates, with the exception of plates 159, 1129 and 2506, which were measured by Mr. Graham, and derived the parallax of + 0″.029 ± 0″.008, which is not inconsistent with the theory of Bottlinger.

The proper motion from the plates is + 0″.045 per year in right ascension, while the value from Boss is + 0″.071.

TABLE 1

PLATES OF β SERPENTIS

No.	Date.	Hour Angle.	Observers.	Weight.
159	1914 July 25	+1^h.2	M	0.9
959	1915 Feb. 26	−0.2	M	0.6
1044	Mar. 12	−0.7	G	0.8
1065	Mar. 14	−0.8	G	0.6
1129	Mar. 29	0.0	G	1.0
1403	June 27	+0.7	G	0.9
1404	June 27	+1.1	G	0.9
1431	July 6	+0.3	Ol	0.9
2384	1916 Feb. 7	−1.0	G	0.7
2385	Feb. 7	−0.6	G	0.8
2506	Mar. 17	−0.2	G	0.8
2532	Mar. 30	−0.2	A	1.0
2717	June 17	+0.5	Ol, L	0.6
2744	June 21	+0.9	M	0.9
2813	July 12	−0.3	M	1.0
2814	July 12	+0.1	M	1.0
4112	1917 June 23	+0.3	M, B	1.0
4113	June 23	+0.6	M, B	1.0
4182	July 28	+0.8	A	1.0
4208	July 31	+0.6	A	0.8

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	−73.0	+18.4	+0.093
2	.16	−33.0	+27.6	.234
3	.38	+15.2	+22.3	.333
4	.12	+43.4	−27.2	.195
5	.12	+47.4	−41.1	+0.145
Parallax star	0.18	+ 5.9	+ 4.3	

TABLE 2

REDUCTIONS FOR β SERPENTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
159	−0.0018	0.9	−0.892	−571	−0.0016	−0″.03
959	− .0008	0.6	+ .951	−355	+ .0012	+ .02
1044	+ .0030	0.8	+ .886	−341	− .0026	− .05
1065	− .0012	0.6	+ .872	−339	+ .0016	+ .02
1129	+ .0018	1.0	+ .738	−324	− .0015	− .03
1403	− .0014	0.9	− .603	−234	+ .0004	+ .01
1404	− .0022	0.9	− .603	−234	+ .0012	+ .02
1431	− .0001	0.9	− .713	−225	− .0010	− .02
2384	+ .0018	0.7	+ .948	− 9	+ .0007	+ .01
2385	+ .0030	0.8	+ .948	− 9	− .0005	− .01
2506	+ .0019	0.8	+ .844	+ 30	+ .0007	+ .01
2532	+ .0014	1.0	+ .719	+ 43	+ .0011	+ .02
2717	+ .0025	0.6	− .475	+122	− .0012	− .02
2744	− .0021	0.9	− .532	+126	+ .0033	+ .06
2813	− .0016	1.0	− .785	+147	+ .0026	+ .05
2814	.0000	1.0	− .785	+147	+ .0010	+ .02
4112	+ .0030	1.0	− .556	+493	+ .0004	+ .01
4113	+ .0065	1.0	− .556	+493	− .0031	− .06
4182	+ .0034	1.0	− .914	+498	− .0005	− .01
4208	+0.0045	0.8	−0.931	+531	−0.0014	−0.03

The normal equations are:

$$17.2c + 2.921\mu - 2.2777\pi = + 0.0191 \text{ mm.}$$
$$+ 180.8927\mu - 16.9037\pi = + 0.0879 \text{ mm.}$$
$$+ 10.2041\pi = + 0.0014 \text{ mm.}$$

from which:

$c = + 0.00120$ mm.

$\mu = + 0.00060$ mm. $= + 0''.0124$, or $+ 0''.045$ per year.

$\pi = + 0.00139$ mm. $= + \mathbf{0''.029} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00112 \text{ mm.} = \pm 0''.023.$$

γ SERPENTIS ($15^h\ 51^m$; $+15°\ 59'$)

This star of 3.86 magnitude and of F8 type, has a considerable proper motion of 1".34 per year. Several values of the parallax have been found, as follows:

Parallax.	Authority.	Method.
+0".090±0".043	Chase	Heliometer
− .081± .024	Russell	Photography
+ .05 ± .028	Flint	Meridian Circle
+ .053± .009	Allegheny	Photography
+0.132	Adams	Spectrograph

Mr. Alden measured the McCormick plates, and found a parallax of + 0".098 ± 0".008 with a proper motion of + 0".278 in right ascension, while the value from Boss is + 0".302.

TABLE 1

PLATES OF γ SERPENTIS

No.	Date.	Hour Angle.	Observers.	Weight.
1045	1915 Mar. 12	−0.3	G	0.7
1140	Mar. 31	−0.5	A	1.0
1201	Apr. 14	−0.2	A	1.0
1416	June 30	+0.8	A	0.8
1455	July 13	0.0	Ol	0.9
2533	1916 Mar. 30	+0.1	A	1.0
2534	Mar. 30	+0.6	A	0.9
2561	Apr. 6	−0.1	A	1.0
2562	Apr. 6	+0.5	A	1.0
2573	Apr. 17	−0.6	Ol	0.4*
2574	Apr. 17	−0.1	Ol	0.6
2726	June 18	+0.6	M, L	0.9
2727	June 18	+1.0	M, L	0.8
2787	July 3	+1.3	L	0.7
2826	July 19	+0.1	M	0.9
2827	July 19	+0.6	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−50.3	− 7.3	+0.2377
2	.10	− 7.0	+26.8	.2635
3	.10	+17.2	+23.7	.2657
4	.12	+40.1	−43.2	+0.2331
Parallax star	0.10	+ 0.1	+ 1.6	

TABLE 2

REDUCTIONS FOR γ SERPENTIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1045	−0.0088	0.7	+0.905	−315	+0.0021	+0″.04
1140	− .0061	1.0	+ .747	−296	− .0006	− .01
1201	− .0066	1.0	+ .578	−282	− .0004	− .01
1416	− .0121	0.8	− .610	−205	+ .0023	+ .04
1455	− .0076	0.9	− .764	−192	− .0024	− .05
2533	+ .0065	1.0	+ .744	+ 69	+ .0001	.00
2534	+ .0078	0.9	+ .744	+ 69	− .0012	− .02
2561	+ .0049	1.0	+ .670	+ 76	+ .0016	+ .03
2562	+ .0065	1.0	+ .670	+ 76	.0000	.00
2573	+ .0048	0.4	+ .527	+ 87	+ .0014	+ .02
2574	+ .0092	0.6	+ .527	+ 87	− .0030	− .05
2726	+ .0050	0.9	− .453	+149	− .0011	− .02
2727	+ .0038	0.8	− .453	+149	+ .0001	.00
2787	+ .0018	0.7	− .658	+164	+ .0016	+ .03
2826	+ .0025	0.9	− .838	+180	+ .0007	+ .01
2827	+0.0033	1.0	−0.838	+180	−0.0001	0.00

The normal equations are:

$$13.6c - 0.551\mu + 1.2406\pi = + 0.0113 \text{ mm.}$$
$$+ 44.9691\mu - 5.8325\pi = + 0.1368 \text{ mm.}$$
$$+ 6.5019\pi = + 0.0099 \text{ mm.}$$

from which:

$c = +0.00055$ mm.

$\mu = +0.00366$ mm. $= +0''.0761$, or $+0''.278$ per year.

$\pi = +0.00470$ mm. $= +\mathbf{0''.098} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

± 0.00097 mm. $= \pm 0''.020$.

ρ CORONÆ BOREALIS ($15^h\ 57^m$; $+33°\ 36'$)

This star of F type, of magnitude 5.43 has a total proper motion of $0''.81$. Its parallax has been determined by the Yale heliometer with the result $+0''.023 \pm 0''.045$. The Allegheny value is $+0''.045 \pm 0''.005$. Adams by the spectroscopic method obtained the value, $+0''.040$. Miss Hawes measured the plates and derived the relative parallax of $+0''.018 \pm 0''.012$, and a proper motion in right ascension $-0''.187$, while the corresponding value from Boss is $-0''.213$.

TABLE 1

PLATES OF ρ CORONÆ

No.	Date.	Hour Angle.	Observers.	Weight.
5304	1918 Apr. 8	$-1^h.0$	M	0.8
5307	Apr. 22	−0.5	A	1.0
5308	Apr. 22	−0.1	A	1.0
5322	Apr. 27	−0.4	Ol	0.9
5463	June 19	−0.5	A	1.0
5464	June 19	−0.2	A	1.0
5523	July 4	−0.2	A	1.3*
5527	July 6	−0.1	A	1.0
6448	1919 Feb. 1	−0.8	M	1.0
6639	Mar. 6	−0.3	Ol	1.1*
6683	Mar. 12	−1.0	H	0.7
6684	Mar. 12	−0.6	H	1.0
6841	Apr. 6	−0.4	H	1.0
6842	Apr. 6	−0.1	H	1.0
7284	July 5	−0.1	H	1.0
7302	July 11	+0.1	H	0.9
7307	July 12	0.0	D	0.7†
7308	July 13	−0.1	F	0.7†

* Three exposures. † One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−71.7	−13.6	+0.202
2	.08	−49.6	+ 2.6	.172
3	.08	+ 8.9	−17.5	.193
4	.08	+23.4	+29.5	.115
5	.09	+35.4	−15.0	.184
6	.12	+53.6	+14.0	+0.134
Parallax star	0.13	− 4.96	− 3.17	

TABLE 2

REDUCTIONS FOR ρ CORONÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
5304	−0.0524	0.8	+0.539	−225	+0.0007	+0″.01
5307	− .0472	1.0	+ .483	−221	− .0047	− .10
5308	− .0471	1.0	+ .483	−221	− .0048	− .10
5322	− .0528	0.9	+ .408	−216	+ .0007	+ .01
5463	− .0550	1.0	− .442	−163	+ .0010	+ .02
5464	− .0541	1.0	− .442	−163	+ .0001	.00
5523	− .0572	1.3	− .649	−148	+ .0026	+ .06
5527	− .0582	1.0	− .673	−146	+ .0036	+ .07
6448	− .0582	1.0	+ .913	+ 64	.0000	.00
6639	− .0607	1.1	+ .942	+ 97	+ .0017	+ .04
6683	− .0591	0.7	+ .914	+103	.0000	.00
6684	− .0614	1.0	+ .914	+103	+ .0023	+ .05
6841	− .0590	1.0	+ .695	+128	− .0009	− .02
6842	− .0624	1.0	+ .695	+128	+ .0025	+ .05
7284	− .0634	1.0	− .658	+218	+ .0002	.00
7302	− .0585	0.9	− .729	+224	− .0049	− .10
7307	− .0623	0.7	− .740	+225	− .0011	− .02
7308	−0.0624	0.7	−0.751	+226	−0.0010	−0.02

The normal equations are:

$$17.1c - 1.437\mu + 1.8989\pi = - 0.9779 \text{ mm.}$$
$$+ 51.2224\mu - 0.5147\pi = - 0.0380 \text{ mm.}$$
$$+ 8.12530\pi = - 0.1010 \text{ mm.}$$

from which:

$c = - 0.05748$ mm.

$\mu = - 0.00235$ mm. $= - 0''.0511$, or $- 0''.187$ per year.

$\pi = + 0.00085$ mm. $= + \mathbf{0''.018 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.0018 \text{ mm.} = \pm 0''.037.$$

ξ SCORPII ($15^h\ 59^m$; $-11°\ 5'$)

This is a most interesting system discovered by Sir William Herschel. Since its discovery, the companion has described two and a half revolutions about the primary. The best orbit is that of Aitken who finds a period of 44.70 years. According to Aitken, the two components are of 4.8 and 5.1 respectively, though many of the early observers regarded the companion as the brighter. Distant 7″ from this pair AB is a third star C forming a physical system with AB, thus making a triple system. Star C is of magnitude 7.2. The diameters below give the dimensions where both parallax stars were visible on the plate. Many of the plates were taken with the opening in the rotating sector reduced in size. The diameter of AB was then reduced to 0.22 mm. The plates of the series were measured by Mr. Mitchell. For the system AB, he found a parallax of $+ 0''.019 \pm 0''.010$, with an annual proper motion of $- 0''.018$ per year in right ascension. For the star C, the parallax is $+ 0''.046 \pm 0''.012$, with the annual proper motion in right ascension of $- 0''.064$ per year. The proper motion of the comparison stars used caused by the motion of the sun through spaces amounts to approximately $- 0''.008$ per year in right ascension. Hence, the proper motions from the photographs of AB and C referred to the equator should be $- 0''.026$ and $- 0''.072$, respectively. Boss finds the proper motions for AB and C to be equal to $- 0''.062$ and $- 0''.075$, respectively. The difference in proper

motions for AB between the present photographs and Boss show the effects of orbital motion. The six different seasons when the system AB was photographed were at the times and when the position angles and distances of the companion were as follows:

1914.52	166°.0	0″.87
15.21	168.6	0.91
15.51	169.8	0.93
16.24	171.4	0.96
17.26	173.9	1.01
17.49	174.5	1.03

The only interpretation of the present measures possible is that the companion has a greater mass than the primary, but as the orbital motion is so slow, and the proper motion of the center of gravity uncertain, it is not possible to have very great confidence in the results.

Combining the results of the measures of the parallax of AB and C the parallax of the system is:

$$+ 0''.030 \pm 0''.008.$$

The only other measure of the parallax is by Lee from photographs with the 40-inch refractor at Yerkes. Lee obtained the parallax of the system to be $+ 0''.050 \pm 0''.005$.

The McCormick value of the parallax makes the mass of the system AB to be 4.36 times that of the sun, while the Yerkes value makes the mass 1.05 that of the sun.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.	
				AB.	C.
	mm.	mm.	mm.		
1	0.14	−38.4	− 1.2	+0.228	+0.220
2	.10	+ 3.8	+13.4	.255	.260
3	.25	+ 4.4	+13.5	.255	.260
4	.22	+30.2	−25.7	+0.262	+0.260
System AB	.30	+ 1.3	− 0.1		
Companion C	0.14	+ 1.6	0.0		

TABLE 1

PLATES OF ξ SCORPII

No.	Date.	Hour Angle.	Observers.	Weight.
114	1914 July 8	+1ʰ8	M,Ol	0.7
129	July 12	+1.6	M	0.7
135	July 18	+1.4	M	1.0
932	1915 Feb. 20	−0.6	G	0.7
946	Feb. 22	−0.2	G	0.8
999	Mar. 3	−0.2	M	0.7
1046	Mar. 12	+0.3	G	0.7
1047	Mar. 12	+0.8	G	0.9
1181	Apr. 12	−0.4	M	1.0
1182	Apr. 12	−0.1	M	0.7
1423	July 2	+0.6	A	1.0
1424	July 2	+1.0	A	0.9
1425	July 2	+1.4	A	0.9
1453	July 11	+0.4	G	0.7
2415	1916 Feb. 19	−0.2	M	0.5*
2468	Mar. 11	+0.1	M	0.7
2470	Mar. 11	+0.8	M	0.8
2549	Apr. 4	−0.4	M	0.7
2550	Apr. 4	−0.1	M	0.9
2551	Apr. 4	+0.2	M	1.0
2552	Apr. 4	+0.5	M	0.8
3842	1917 Apr. 3	−0.4	M	1.0
3843	Apr. 3	−0.1	M	1.0
3855	Apr. 7	−0.6	L	1.0
3856	Apr. 7	−0.3	L	1.0
4129	June 29	+0.9	B, Ol	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR ξ SCORPII, SYSTEM AB

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
114	+0.0192	0.7	−0.692	−497	+0.0011	+0″.02
129	+ .0206	0.7	− .738	−493	− .0003	− .01
135	+ .0202	1.0	− .800	−487	.0000	.00
932	+ .0184	0.7	+ .969	−270	+ .0029	+ .05
946	+ .0216	0.8	+ .969	−268	− .0003	− .01
1046	+ .0180	0.7	+ .917	−250	+ .0032	+ .06
1047	+ .0206	0.8	+ .917	−250	+ .0006	+ .01
1181	+ .0227	1.0	+ .629	−219	− .0018	− .04
1182	+ .0185	0.7	+ .629	−219	+ .0024	+ .04
1423	+ .0218	1.0	− .614	−138	− .0022	− .05
1424	+ .0176	0.9	− .614	−138	+ .0020	+ .04
1425	+ .0170	0.9	− .614	−138	+ .0026	+ .05
1453	+ .0219	0.7	− .724	−129	− .0025	− .04
2415	+ .0243	0.5	+ .969	+ 94	− .0039	− .06
2468	+ .0231	0.7	+ .919	+115	− .0028	− .05
2470	+ .0236	0.8	+ .919	+115	− .0033	− .06
2549	+ .0216	0.7	+ .716	+139	− .0015	− .03
2550	+ .0223	0.9	+ .716	+139	− .0022	− .04
2551	+ .0190	1.0	+ .716	+139	+ .0011	+ .02
2552	+ .0220	0.9	+ .716	+139	− .0019	− .04
3842	+ .0185	1.0	+ .730	+503	+ .0007	+ .01
3843	+ .0152	1.0	+ .730	+503	+ .0040	+ .08
3855	+ .0169	1.0	+ .684	+507	+ .0023	+ .05
3856	+ .0200	1.0	+ .684	+507	− .0008	− .02
4129	+0.0187	1.0	−0.581	+590	−0.0008	−0.02

The normal equations are:

$$21.1c + 5.086\mu + 6.4873\pi = + 0.4217 \text{ mm.}$$
$$+ 238.9049\mu + 18.5628\pi = + 0.0605 \text{ mm.}$$
$$+ 11.9910\pi = + 0.1345 \text{ mm.}$$

from which:

$c = +0.01977$ mm.

$\mu = -0.00024$ mm. $= -0''.0049$, or $-0''.018$ per year.

$\pi = +0.00089$ mm. $= +\mathbf{0''.018 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00140 \text{ mm.} = \pm 0''.029.$$

TABLE 3

REDUCTIONS FOR ξ SCORPII, COMPANION C

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
114	+0.0462	0.7	−0.692	−278	+0.0013	+0″.02
129	+ .0501	0.7	− .738	−274	− .0027	− .05
135	+ .0453	1.0	− .800	−268	+ .0019	+ .04
932	+ .0473	0.7	+ .969	− 51	+ .0020	+ .04
999	+ .0478	0.7	+ .955	− 40	+ .0014	+ .02
1046	+ .0511	0.7	+ .917	− 31	− .0021	− .04
1047	+ .0506	1.0	+ .917	− 31	− .0016	− .03
1423	+ .0462	0.9	− .614	+ 81	− .0015	− .03
1424	+ .0425	0.9	− .614	+ 81	+ .0022	+ .04
1453	+ .0469	0.7	− .724	+ 90	− .0025	− .04
2415	+ .0476	0.5	+ .969	+313	− .0014	− .02
2468	+ .0467	0.7	+ .919	+334	− .0008	− .01
2552	+0.0426	0.8	+0.716	+358	+0.0027	+0.05

The normal equations are:

$$10.0c + 1.147\mu + 1.1933\pi = +0.4689 \text{ mm.}$$
$$+ 43.0135\mu + 8.1739\pi = +0.0354 \text{ mm.}$$
$$+ 6.5980\pi = +0.0635 \text{ mm.}$$

from which:

$c = +0.04672$ mm.

$\mu = -0.00084$ mm. $= -0''.0175$, or $-0''.064$ per year.

$\pi = +0.00221$ mm. $= +\mathbf{0''.046 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00131 \text{ mm.} = \pm 0''.027.$$

ν SCORPII ($16^h\ 6^m$; $-19°\ 12'$)

The brighter star of ν Scorpii is of 4.29 magnitude, and of B3 type. It is a double, β 120, of magnitudes 4.4 and 5.9, respectively, and separated by less than 1".0. This pair AB does not show orbital motion. 40" distant from AB is another pair of magnitude 6.5, which was discovered by Mitchel, of which the components are separated by about "2", and which differ about one magnitude in brightness. According to Burnham, "the four components are moving together, and undoubtedly form a vast quadruple system." The parallaxes of the system AB and CD were measured by Mr. Mitchell from one series of plates. The rotating sector was utilized to reduce the brightness of the parallax stars. The photographs were taken so that the images of brighter pair AB should be of the same size on the plates as the average comparison star. As a result, the fainter star CD was too faint. To have made this equal in size to the comparison stars would have required another series of plates. More confidence should therefore be placed in the results from

TABLE 1

PLATES OF ν SCORPII

No.	Date.	Hour Angle.	Observers.	Weight.
141	1914 July 19	+1h4	M	0.8
146	July 21	+2.0	Ol	0.8
972	1915 Mar. 1	−0.2	M	0.8
973	Mar. 1	+0.3	M	0.8
1000	Mar. 3	+0.3	M	0.7
1033	Mar. 10	−0.5	G	0.7
1220	Apr. 17	−0.4	M	0.8
1253	Apr. 26	−0.4	G	0.9
1506	July 24	+0.5	Ol	0.9
1507	July 24	+1.2	Ol	0.6
1515	July 25	+0.3	G	0.7
2591	1916 Apr. 25	−0.5	A	1.0
2592	Apr. 25	0.0	A	1.0
2599	Apr. 26	−0.5	Ol	0.7

AB. Since these stars form a physical system, their combined parallax has the value:

$$+ 0''.021 \pm 0''.009.$$

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.	
				Principal Star.	Companion.
	mm.	mm.	mm.		
1	0.18	−52.4	− 1.1	+0.273	+0.279
2	.26	+ 5.6	+55.8	.087	.107
3	.26	+15.8	−33.9	.342	.327
4	.26	+31.0	−20.8	+0.298	+0.287
Principal star AB	.25	+ 0.8	−13.2		
Companion	0.10	+ 0.1	−11.4		

TABLE 2

REDUCTIONS FOR ν SCORPII, PRINCIPAL STAR AB

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
141	+0.0365	0.8	−0.794	−317	−0.0041	−0″.07
146	+ .0298	0.8	− .814	−315	+ .0025	+ .05
972	+ .0324	0.8	+ .966	− 92	− .0014	− .03
973	+ .0294	0.8	+ .969	− 92	+ .0015	+ .03
1000	+ .0297	0.7	+ .962	− 90	+ .0012	+ .02
1033	+ .0298	0.7	+ .939	− 83	+ .0010	+ .02
1220	+ .0307	0.8	+ .589	− 45	− .0004	− .01
1253	+ .0308	0.9	+ .463	− 36	− .0007	− .01
1506	+ .0268	0.9	− .839	+ 53	+ .0017	+ .03
1507	+ .0286	0.6	− .839	+ 53	.0000	.00
1515	+ .0281	0.7	− .847	+ 54	+ .0004	+ .01
2591	+ .0257	1.0	+ .466	+329	+ .0007	+ .01
2592	+ .0266	1.0	+ .466	+329	− .0002	.00
2599	+0.0289	0.7	+0.452	+330	−0.0025	−0.04

The normal equations are:

$$11.2c + 1.640\mu + 1.8772\pi = + 0.3299 \text{ mm.}$$
$$+ 48.5559\mu + 4.2503\pi = + 0.0011 \text{ mm.}$$
$$+ 6.4030\pi = + 0.0543 \text{ mm.}$$

from which:

$c = + 0.02952$ mm.

$\mu = - 0.00102$ mm. $= - 0''.0212$, or $- 0''.077$ per year.

$\pi = + 0.00051$ mm. $= + \mathbf{0''.010 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00112 \text{ mm.} = \pm 0''.023.$$

TABLE 3

REDUCTIONS FOR ν SCORPII, COMPANION CD

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
141	+0.0381	0.8	−0.794	−317	−0.0009	−0″.02
972	+ .0354	0.8	+ .966	− 92	+ .0036	+ .06
973	+ .0418	0.6	+ .966	− 92	− .0028	− .04
1000	+ .0374	0.7	+ .962	− 90	+ .0016	+ .03
1033	+ .0400	0.7	+ .939	− 83	− .0011	− .02
1220	+ .0393	0.8	+ .589	− 45	− .0014	− .03
1253	+ .0378	0.9	+ .463	− 36	− .0002	.00
1506	+ .0311	0.9	− .839	+ 53	+ .0032	+ .06
1515	+ .0366	0.7	− .847	+ 54	− .0024	− .04
2591	+ .0328	1.0	+ .466	+329	+ .0020	+ .04
2592	+ .0370	1.0	+ .466	+329	− .0022	− .04
2599	+0.0358	0.5	+0.452	+330	−0.0010	−0.01

The normal equations are:

$$9.4c + 3.366\mu + 2.7458\pi = + 0.3448 \text{ mm.}$$
$$+ 38.1021\mu + 2.3474\pi = + 0.0984 \text{ mm.}$$
$$+ 5.2184\pi = + 0.1086 \text{ mm.}$$

from which:

$c = + 0.03637$ mm.

$\mu = - 0.00075$ mm. $= - 0''.0157$, or $- 0''.057$ per year.

$\pi = + 0.00201$ mm. $= + \mathbf{0''.042 \pm 0''.015}$.

Probable error of plate of unit weight

$$\pm 0.00146 \text{ mm.} = \pm 0''.030.$$

49 SERPENTIS ($16^h\ 8^m$; + 13° 47′)

This is a double star, Σ 2021, both of A-types, and separated by a distance of 4″. According to Burnham, they have a large common proper motion of 0″.45, and they may form a binary of very long period, or a system of the 61 Cygni class. Eighteen of the McCormick series of plates were measured by Mr. Mitchell, the balance by Mr. Lamb. The proper motions of the two stars in right ascension were found from the photographs to be + 0″.213 and + 0″.205, respectively, while the mean proper motion from Boss is + 0″.169. The parallaxes of the two stars are + 0″.075 ± 0″.010, and + 0″.073 ± 0″.011, respectively, from which there results a mean parallax of the system of

+ 0″.074 ± 0″.007

The spectroscopic parallax of Adams and Joy is + 0″.040.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.17	−32.0	+32.1	+0.1961
2	.12	−26.8	−23.6	.1911
3	.12	−23.9	+ 9.4	.1954
4	.22	+ 5.2	−51.8	.1954
5	.14	+77.5	+33.9	+0.2220
Principal star	.14	+ 2.2	+ 1.0	
Companion	0.13			

TABLE 1

PLATES OF 49 SERPENTIS

No.	Date.	Hour Angle.	Observers.	Weight.
1093	1915 Mar. 20	−0ʰ4	M	0.8
1117	Mar. 27	−0.9	G	0.9
1118	Mar. 27	−0.5	G	1.0
1176	Apr. 11	+0.3	A	1.0
2762	1916 June 23	−0.4	M, L	0.7
3726	1917 Mar. 6	−0.3	L	0.8
3727	Mar. 6	+0.1	L	0.8
3818	Mar. 25	−0.6	L	0.8
3819	Mar. 25	−0.2	L	0.8
4077	June 17	+0.3	M, B	1.0
4078	June 17	+0.7	M, B	0.7
5109	1918 Feb. 17	−0.2	Ds	0.5*
5124	Feb. 22	−0.2	A	0.7*
5141	Feb. 26	−1.0	A	0.6*
5142	Feb. 26	−0.5	A	0.9
5214	Mar. 19	−0.2	A	1.0
5225	Mar. 26	−0.5	A	1.0
5226	Mar. 26	0.0	A	1.0
5490	June 28	−0.1	Ol	0.7
5491	June 28	+0.3	Ol	0.7*
5501	July 2	+0.2	A	1.0
5502	July 2	+0.7	A	1.0
6577	1919 Feb. 26	−1.0	M	1.0
6578	Feb. 26	−0.6	M	1.0
6614	Mar. 3	−0.7	H	0.7*
6615	Mar. 3	−0.3	H	0.7*

* One exposure.

The normal equations are:

$$21.8c - 2.033\mu + 11.4305\pi = -0.3387 \text{ mm.}$$
$$+ 466.8694\mu - 6.8060\pi = +1.3224 \text{ mm.}$$
$$+ 14.3871\pi = -0.1633 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR 49 SERPENTIS, PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1093	−0.0378	0.8	+0.885	−892	−0.0012	−0″.02
1117	− .0392	0.9	+ .830	−885	+ .0002	.0
1118	− .0368	1.0	+ .830	−885	− .0022	− .05
1176	− .0420	1.0	+ .672	−870	+ .0028	+ .06
2762	− .0298	0.7	− .467	−431	− .0012	− .02
3726	− .0206	0.8	+ .955	−175	+ .0020	+ .04
3727	− .0200	0.8	+ .955	−175	+ .0014	+ .02
3818	− .0196	0.8	+ .843	−156	+ .0011	+ .02
3819	− .0196	0.8	+ .843	−156	+ .0011	+ .02
4077	− .0202	1.0	− .374	− 72	− .0003	− .01
4078	− .0166	0.7	− .374	− 72	− .0039	− .07
5109	− .0110	0.5	+ .967	+173	+ .0022	+ .03
5124	− .0100	0.7	+ .973	+178	+ .0014	+ .02
5141	− .0082	0.6	+ .972	+182	− .0003	− .01
5142	− .0100	0.9	+ .972	+182	+ .0015	+ .03
5214	− .0060	1.0	+ .890	+203	− .0022	− .05
5225	− .0060	1.0	+ .836	+210	− .0022	− .05
5226	− .0070	1.0	+ .836	+210	− .0012	− .02
5490	− .0058	0.7	− .532	+304	− .0048	− .08
5491	− .0131	0.7	− .532	+304	+ .0025	+ .04
5501	− .0152	1.0	− .587	+308	+ .0046	+ .10
5502	− .0110	1.0	− .587	+308	+ .0004	+ .01
6577	− .0010	1.0	+ .972	+547	+ .0027	+ .06
6578	+ .0026	1.0	+ .972	+547	− .0009	− .02
6614	+ .0028	0.7	+ .964	+552	− .0010	− .02
6615	+0.0049	0.7	+0.964	+552	−0.0031	−0.05

from which:

$c = -0.01717$ mm.

$\mu = +0.00281$ mm. $= +0''.0585$, or $+0''.213$ per year.

$\pi = +0.00362$ mm. $= +$ **0″.075 ± 0″.010.**

Probable error of plate of unit weight

± 0.00145 mm. $= \pm 0''.030$.

TABLE 3

REDUCTIONS FOR 49 SERPENTIS, COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1093	+0.0382	0.8	+0.885	−892	−0.0036	−0″.07
1117	+ .0329	0.9	+ .830	−885	+ .0017	+ .03
1118	+ .0368	1.0	+ .830	−885	− .0022	− .05
1176	+ .0312	1.0	+ .672	−870	+ .0033	+ .07
2762	+ .0422	0.7	− .467	−431	+ .0002	.00
3726	+ .0497	0.8	+ .955	−175	+ .0045	+ .08
3727	+ .0521	0.8	+ .955	−175	+ .0021	+ .04
3818	+ .0567	0.8	+ .843	−156	− .0024	− .04
3819	+ .0548	0.8	+ .843	−156	− .0004	− .01
4077	+ .0522	1.0	− .374	− 72	+ .0002	.00
4078	+ .0570	0.7	− .374	− 72	− .0046	− .08
5109	+ .0586	0.5	+ .967	+173	+ .0051	+ .07
5124	+ .0640	0.7	+ .973	+178	− .0002	.00
5141	+ .0604	0.6	+ .972	+182	+ .0035	+ .06
5142	+ .0659	0.9	+ .972	+182	− .0020	− .04
5214	+ .0650	1.0	+ .890	+203	− .0008	− .02
5225	+ .0668	1.0	+ .836	+210	− .0026	− .05
5226	+ .0660	1.0	+ .836	+210	− .0018	− .04
5490	+ .0641	0.7	− .532	+304	− .0021	− .04
5491	+ .0611	0.7	− .532	+304	+ .0009	+ .01
5501	+ .0602	1.0	− .587	+308	+ .0017	+ .04
5502	+ .0600	1.0	− .587	+308	+ .0019	+ .04
6577	+ .0756	1.0	+ .972	+547	− .0018	− .04
6578	+ .0754	1.0	+ .972	+547	− .0016	− .03
6614	+ .0719	0.7	+ .964	+552	+ .0020	+ .04
6615	+0.0711	0.7	+0.964	+552	+0.0028	+0.05

The normal equations are:

$$21.8c - 2.033\mu + 11.4305\pi = + 1.2468 \text{ mm.}$$
$$+ 466.8694\mu - 6.8060\pi = + 1.1233 \text{ mm.}$$
$$+ 14.3871\pi = + 0.6676 \text{ mm.}$$

from which:

$c = +0.05561$ mm.
$\mu = +0.00270$ mm. $= +0''.0561$, or $+0''.205$ per year.
$\pi = +0.00350$ mm. $= +\mathbf{0''.073 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00159 \text{ mm.} = \pm 0''.033.$$

δ OPHIUCHI ($16^h\ 9^m$; $-3°\ 26'$)

The only parallax determined for this star of magnitude 3.03, of type Ma, and of total proper motion $0''.160$ is the spectrographic

TABLE 1

PLATES OF δ OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
5143	1918 Feb. 26	$+0^h.1$	A	0.9
5210	Mar. 18	−0.1	A	1.0
5211	Mar. 18	+0.3	A	1.0
5336	May 1	−0.3	A	1.0
5516	July 3	+0.4	A	1.0
5517	July 3	+0.8	A	1.0
5524	July 4	+0.2	A	1.0
5525	July 4	+0.5	A	1.0
6685	1919 Mar. 12	−0.3	H	0.9
6686	Mar. 12	0.0	H	1.0
6698	Mar. 18	+0.3	D	1.0
6790	Mar. 30	−0.2	F	1.0
6791	Mar. 30	+0.2	F	1.0
6802	Apr. 1	−0.9	D	0.8
7271	July 2	−0.3	F	1.0
7272	July 2	0.0	F	1.0
7273	July 2	+0.4	F	1.0
7274	July 2	+0.7	F	1.0
7411	Aug. 3	+1.5	F	0.9
7423	Aug. 4	+1.1	H	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−40.4	+ 7.1	+0.4306
2	.20	− 2.1	+28.9	.1266
3	.14	+42.5	−36.0	+0.4427
Parallax star	0.18	+ 1.15	− 9.22	

TABLE 2

REDUCTIONS FOR δ OPHIUCHI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
5143	−0.0382	0.9	+0.972	−298	+0.0013	+0″.02
5210	− .0353	1.0	+ .898	−278	− .0018	− .04
5211	− .0351	1.0	+ .898	−278	− .0020	− .04
5336	− .0417	1.0	+ .395	−234	+ .0035	+ .07
5516	− .0449	1.0	− .599	−171	+ .0047	+ .10
5517	− .0418	1.0	− .599	−171	+ .0016	+ .03
5524	− .0362	1.0	− .612	−170	− .0040	− .08
5525	− .0372	1.0	− .612	−170	− .0030	− .06
6685	− .0390	0.9	+ .933	+ 81	+ .0010	+ .02
6686	− .0400	1.0	+ .933	+ 81	+ .0020	+ .04
6698	− .0372	1.0	+ .899	+ 87	− .0008	− .02
6790	− .0377	1.0	+ .804	+ 99	− .0006	− .01
6791	− .0382	1.0	+ .804	+ 99	− .0001	.00
6802	− .0370	0.8	+ .785	+101	− .0013	− .02
7271	− .0404	1.0	− .582	+193	− .0007	− .01
7272	− .0410	1.0	− .582	+193	− .0001	.00
7273	− .0400	1.0	− .582	+193	− .0011	− .02
7274	− .0408	1.0	− .582	+193	− .0003	− .01
7411	− .0434	0.9	− .912	+225	+ .0016	+ .03
7423	−0.0424	0.9	−0.918	+226	+0.0005	+0.01

result of Adams with the result + 0″.046. Miss Darkow measured the photographs and determined a relative parallax + 0″.040 ± 0″.010 with a proper motion in right ascension − 0″.020 while the corresponding value from Boss is − 0″.048.

The normal equations are:

$$19.4c - 0.426\mu + 1.5765\pi = - 0.7638 \text{ mm.}$$
$$+ 69.3854\mu - 8.1575\pi = - 0.0166 \text{ mm.}$$
$$+ 11.1957\pi = - 0.0390 \text{ mm.}$$

from which:

$c = - 0.03953$ mm.
$\mu = - 0.00026$ mm. $= - 0''.0054$, or $- 0''.020$ per year.
$\pi = + 0.00190$ mm. $= + \mathbf{0''.040 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00149 \text{ mm.} = \pm 0''.031.$$

ϵ OPHIUCHI ($16^h\ 13^m$; $-4°\ 27'$)

The only parallax for this star of magnitude 3.34, of spectrum K and of total proper motion 0″.085 is the spectrographic result of Adams with the absolute value + 0″.025. Miss Hawes measured the photographs, and determined a relative parallax of + 0″.046 ± 0″.012, and a proper motion in right ascension + 0″.102 while the corresponding value from Boss is + 0″.079.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−61.5	+36.5	+0.274
2	.14	+ 9.6	+23.1	.208
3	.09	+18.9	−37.6	.278
4	.04	+33.0	−22.0	+0.240
Parallax star	0.14	− 1.70	− 0.91	

TABLE 1

PLATES OF ϵ OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
1055	1915 Mar. 13	$-0^h.2$	M	0.4
1075	Mar. 17	−0.1	G	0.8
1108	Mar. 24	−0.4	G	0.9
1109	Mar. 24	+0.1	G	0.5*
1169	Apr. 8	−0.3	G	0.6
3865	1917 Apr. 9	−0.6	M	0.8
3893	Apr. 18	−0.9	A	1.0
3894	Apr. 18	−0.5	A	0.7
4101	June 22	0.0	Ol, B	1.0
4102	June 22	+0.6	Ol, B	0.8
4130	June 29	+1.2	Ol, B	0.8
5309	1918 Apr. 22	+0.2	A	1.0
5310	Apr. 22	+0.6	A	1.0
5329	Apr. 29	−0.2	A	1.0
5330	Apr. 29	+0.5	A	1.0
5540	July 13	+0.6	A	1.0
5590	Aug. 4	+0.9	A	0.8
5603	Aug. 6	+0.9	A	1.0
6470	1919 Feb. 5	−0.8	M	0.7*
6489	Feb. 6	−0.7	H	1.0
6579	Feb. 26	−0.3	M	1.0
6580	Feb. 26	+0.2	M	1.0
7275	July 2	+1.1	F	1.0
7276	July 2	+1.5	F	1.0
7285	July 5	+0.4	H	0.8
7286	July 5	+0.8	H	1.0

* One exposure.

The normal equations are:

$$22.6c + 40.496\mu + 3.9695\pi = -0.6522 \text{ mm.}$$
$$622.4205\mu - 23.5451\pi = -0.4989 \text{ mm.}$$
$$+ 11.6052\pi = -0.1315 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR ϵ OPHIUCHI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1055	−0.0398	0.4	+0.934	−857	−0.0013	−0″.02
1075	− .0391	0.8	+ .914	−853	− .0020	− .04
1108	− .0407	0.9	+ .865	−846	− .0004	− .01
1109	− .0400	0.5	+ .865	−846	− .0011	− .02
1169	− .0416	0.6	+ .721	−831	+ .0004	+ .01
3865	− .0304	0.8	+ .704	− 99	− .0010	− .02
3893	− .0346	1.0	+ .592	− 90	+ .0030	+ .06
3894	− .0302	0.7	+ .592	− 90	− .0014	− .02
4101	− .0362	1.0	− .434	− 25	+ .0032	+ .07
4102	− .0340	0.8	− .434	− 25	+ .0010	+ .02
4130	− .0351	0.8	− .536	− 18	+ .0020	+ .04
5309	− .0231	1.0	+ .540	+279	− .0036	− .07
5310	− .0241	1.0	+ .540	+279	− .0026	− .05
5329	− .0260	1.0	+ .439	+286	− .0008	− .02
5330	− .0244	1.0	+ .439	+286	− .0024	− .05
5540	− .0303	1.0	− .712	+361	+ .0019	+ .04
5590	− .0282	0.8	− .915	+383	− .0003	− .01
5603	− .0284	1.0	− .927	+385	− .0001	− .00
6470	− .0273	0.7	+ .919	+568	+ .0053	+ .09
6489	− .0238	1.0	+ .924	+569	+ .0018	+ .04
6579	− .0222	1.0	+ .974	+589	+ .0006	+ .01
6580	− .0228	1.0	+ .974	+589	+ .0012	+ .02
7275	− .0216	1.0	− .571	+715	− .0017	− .04
7276	− .0206	1.0	− .571	+715	− .0027	− .06
7285	− .0236	0.8	− .610	+718	+ .0002	+ .00
7286	−0.0218	1.0	− .610	+718	− .0016	− .03

from which:

$c = -0.03165$ mm.

$\mu = +0.00134$ mm. $= +0''.0279$, or $+0''.102$ per year.

$\pi = +0.00222$ mm. $= \mathbf{+0''.046 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00170 \text{ mm.} = \pm 0''.035.$$

η DRACONIS ($16^h\ 22^m$; $+61°\ 44'$)

Two values of the parallax of this star have been published, the meridian circle result of Flint, $+ 0''.080 \pm 0''.032$, and the spectroscopic value of Adams $+ 0''.032$. This is a double star OΣ 312 the principal star of magnitude 2.89, and G5 type, and the companion of 8.1 magnitude at a distance 5″. The rotating sector was used to diminish the brightness of the principal star,

TABLE 1

PLATES OF η DRACONIS

No.	Date.	Hour Angle.	Observers.	Weight.
1085	1915 Mar. 18	−0h6	M	0.7*
1130	Mar. 29	0.0	G	0.9
1141	Mar. 31	−0.4	A	1.0
1148	Apr. 4	−0.2	A	1.0
1446	July 9	−0.2	A	1.0
1465	July 16	−0.4	A	1.0
2474	1916 Mar. 12	−0.3	A	0.9
2475	Mar. 12	−0.7	A	0.9
2580	Apr. 19	−1.0	G	0.8
2606	Apr. 27	−0.7	A	1.0
2607	Apr. 27	−0.4	A	1.0
2803	July 7	−0.6	L	1.0
2804	July 7	−0.3	L	1.0
2806	July 11	−0.9	Ol	0.9
2807	July 11	−0.4	Ol	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−21.0	− 2.1	+0.1531
2	.30	− 0.7	+42.5	.5462
3	.13	+21.7	−40.4	+0.3007
Parallax star	0.20	+ 2.9	+10.7	

and the companion was, consequently, invisible. The stars have a common proper motion 0″.06. Mr. Alden measured the McCormick series of plates and found a proper motion in right ascension of − 0″.022 while Boss has the value − 0″.018.

TABLE 2

REDUCTIONS FOR η DRACONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1085	−0.0104	0.7	+0.922	−275	−0.0012	−0″.02
1130	− .0106	0.9	+ .844	−264	− .0011	− .02
1141	− .0128	1.0	+ .827	−262	+ .0011	+ .02
1148	− .0137	1.0	+ .789	−258	+ .0020	+ .04
1446	− .0118	1.0	− .635	−162	− .0003	− .01
1465	− .0111	1.0	− .719	−155	− .0010	− .02
2474	− .0116	0.9	+ .948	+ 85	− .0010	− .02
2475	− .0130	0.9	+ .948	+ 85	+ .0004	+ .01
2580	− .0156	0.8	+ .605	+123	+ .0028	+ .05
2606	− .0116	1.0	+ .495	+131	− .0012	− .02
2607	− .0107	1.0	+ .495	+131	− .0021	− .04
2803	− .0138	1.0	− .618	+202	+ .0007	+ .01
2804	− .0156	1.0	− .618	+202	+ .0025	+ .05
2806	− .0100	0.9	− .669	+206	− .0031	− .06
2807	−0.0146	0.8	−0.669	+206	+0.0015	+0.03

The normal equations are:

$$13.9c + 0.005\mu + 2.4741\pi = - 0.1732 \text{ mm.}$$
$$+ 51.4320\mu - 7.3363\pi = - 0.0150 \text{ mm.}$$
$$+ 7.3880\pi = - 0.0283 \text{ mm.}$$

from which:

$c = - 0.01247$ mm.

$\mu = - 0.00028$ mm. $= - 0''.0060$, or $- 0''.022$ per year.

$\pi = + 0.00008$ mm. $= + \mathbf{0''.002 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00122 \text{ mm.} = \pm 0''.025.$$

λ OPHIUCHI ($16^h\ 25^m$; $+2°\ 12'$)

According to *Burnham's General Catalogue*, this is a binary of long period which has described an arc of only 90° since its discovery by Struve. As yet, nothing is known of its real orbit, though several have been computed in which the periods range from 89.0 years to 373.5 years. The most probable period is that due to Lewis of 134 years, or that of Lohse of 123.24 years. To add to the interest connected with this star, Frost has found (*Astronomische Nachrichten*, **177**, 174, 1908) that it is a spectroscopic binary. It is of A type, and of magnitude 3.85. Van Biesbroeck (*Astronomical Journal*, **29**, 173, 1916) calls attention to the desirability of investigating the motions of this star in order to determine the ratios of the masses of the components. The present series of photographs were taken while the orbital motion of the companion was almost entirely in declination so that the measures in right ascension, should give a proper motion in right ascension equal to the proper motion of the center of gravity of the system which Boss gives. His value is $-\ 0''.048$ per year, and the value from the McCormick series of plates which were measured by Mr. Alden is $-\ 0''.047$. Three values of the parallax have been given, the result of photographic measures. At Yerkes, Lee derives the value $+\ 0''.018 \pm 0''.003$, at Swarthmore Miller obtains $-\ 0''.004 \pm 0''.005$, while at Allegheny the value of $-\ 0''.010 \pm 0''.008$ is found. Making use of the orbit by Lewis, and the McCormick parallax, the mass of the system is found to be 19.7 times that of the sun.

TABLE 1

PLATES OF λ OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
1290	1915 May 9	−0h3	A	1.0
1300	May 10	−0.2	G	0.8
1489	July 18	+0.6	G	0.9
1490	July 18	+1.0	G	0.7*
1516	July 25	+1.0	G	0.7
1537	Aug. 9	+0.9	G	0.8
2508	1916 Mar. 17	+0.1	G	0.7
2509	Mar. 17	+0.4	G	0.8
2621	Apr. 30	−0.4	A	1.0
2622	Apr. 30	+0.1	A	1.0
2796	July 4	+0.8	M	1.0
2877	Aug. 17	+1.5	A	1.0
2910	Aug. 20	+1.2	A	1.0
3697	1917 Feb. 22	−0.8	M	0.9
3698	Feb. 22	−0.4	M	1.0
3786	Mar. 21	−0.3	L	0.9
3787	Mar. 21	−0.6	L	0.7*
4114	June 23	+0.4	M, B	1.0
4115	June 23	+0.7	M, B	1.0
4183	July 28	+0.4	A	0.9
4184	July 28	+0.7	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−31.9	+45.8	+0.2143
2	.20	−28.2	− 5.6	.2446
3	.17	+ 8.8	−40.0	.2754
4	.16	+51.3	− 0.2	+0.2657
Parallax star	0.20	+ 2.3	− 2.6	

TABLE 2

REDUCTIONS FOR λ OPHIUCHI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1290	+0.0077	1.0	+0.340	−421	+0.0008	+0″.02
1300	+ .0108	0.8	+ .324	−420	− .0023	− .04
1489	+ .0073	0.9	− .733	−351	+ .0004	+ .01
1490	+ .0122	0.7	− .733	−351	− .0046	− .08
1516	+ .0044	0.7	− .807	−344	+ .0032	+ .06
1537	+ .0036	0.8	− .927	−329	+ .0038	+ .07
2508	+ .0054	0.7	+ .929	−108	+ .0015	+ .02
2509	+ .0062	0.8	+ .929	−108	+ .0007	+ .01
2621	+ .0089	1.0	+ .466	− 64	− .0025	− .05
2622	+ .0073	1.0	+ .466	− 64	− .0009	− .02
2796	+ .0044	1.0	− .566	+ 1	+ .0012	+ .02
2877	+ .0070	1.0	− .978	+ 47	− .0019	− .04
2910	+ .0053	1.0	− .981	+ 48	− .0002	.00
3697	+ .0038	0.9	+ .975	+234	+ .0010	+ .02
3698	+ .0056	1.0	+ .975	+234	− .0008	− .02
3786	+ .0032	0.9	+ .908	+261	+ .0014	+ .03
3787	+ .0047	0.7	+ .908	+261	− .0001	.00
4114	+ .0046	1.0	− .402	+355	− .0012	− .02
4115	+ .0009	1.0	− .402	+355	+ .0026	+ .05
4183	+ .0041	0.9	− .840	+390	− .0009	− .02
4184	+0.0026	1.0	−0.840	+390	−0.0004	−0.01

The normal equations are:

$$18.8c + 2.396\mu - 1.1743\pi = + 0.1070 \text{ mm.}$$
$$+ 142.6433\mu + 2.4688\pi = - 0.0728 \text{ mm.}$$
$$+ 10.9598\pi = - 0.0036 \text{ mm.}$$

from which:

$c = + 0.00580$ mm.

$\mu = - 0.00061$ mm. $= - 0''.0128$, or $- 0''.047$ per year.

$\pi = + 0.00043$ mm. $= + \mathbf{0''.009 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00128 \text{ mm.} = \pm 0''.026.$$

η HERCULIS ($16^h\ 39^m$; $+39°\ 6'$)

The older values of the parallax are very discordant, consisting as they do of $+\ 0''.40 \pm 0''.072$ by meridian circle by Belopolsky, $+\ 0''.15 \pm 0''.035$ by meridian circle by Flint, and $+\ 0''.014$

TABLE 1

PLATES OF η HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
2586	1916 Apr. 20	$-1^h.5$	Ol	0.9
2587	Apr. 20	−0.9	Ol	0.9
2616	Apr. 29	−0.8	Ol	0.8
2617	Apr. 29	−0.2	Ol	0.7
2815	July 12	−0.3	M	0.8
3886	1917 Apr. 16	−0.4	A	1.0
3895	Apr. 18	−0.4	A	0.9
3896	Apr. 18	−0.1	A	0.7*
4088	June 18	−0.7	A, B	0.9
4089	June 18	−0.2	A, B	0.9
4151	July 1	−0.3	M	1.0
4152	July 1	0.0	M	0.7*
5240	1918 Mar. 28	−0.8	Ol	0.8
5241	Mar. 28	−0.3	Ol	0.9
5270	Apr. 4	−0.2	Ol	0.9
5286	Apr. 14	−1.2	Ol	1.0
5287	Apr. 14	−0.5	Ol	0.7
5563	July 20	−0.1	A	1.0
5574	July 21	0.0	A	1.0
6779	1919 Mar. 29	−1.7	Ol	1.0
6780	Mar. 29	−1.1	Ol	0.9
6781	Mar. 29	−0.4	Ol	0.9
7348	July 26	−0.3	D	0.9
7364	July 27	−0.2	H	0.9
7365	July 27	+0.1	H	0.6*
7384	July 29	−0.2	D	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR η HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P.)	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2586	+0.0051	0.9	+0.649	−619	−0.0006	−0″.01
2587	+ .0034	0.9	+ .649	−619	+ .0011	+ .02
2616	+ .0051	0.8	+ .528	−610	− .0008	− .02
2617	+ .0064	0.7	+ .528	−610	− .0022	− .04
2815	+ .0045	0.8	− .630	−536	− .0023	− .04
3886	+ .0057	1.0	+ .701	−258	+ .0015	+ .03
3895	+ .0080	0.9	+ .677	−256	− .0008	− .02
3896	+ .0041	0.7	+ .677	−256	+ .0031	+ .05
4088	+ .0045	0.9	− .273	−197	+ .0010	+ .02
4089	+ .0026	0.9	− .273	−197	+ .0029	+ .06
4151	+ .0070	1.0	− .475	−192	− .0019	− .04
4152	+ .0023	0.7	− .475	−192	+ .0028	+ .05
5240	+ .0101	0.8	+ .887	+ 88	+ .0001	.00
5241	+ .0108	0.9	+ .887	+ 88	− .0006	− .01
5270	+ .0075	0.9	+ .829	+ 95	+ .0026	+ .05
5286	+ .0112	1.0	+ .727	+105	− .0012	− .02
5287	+ .0136	0.7	+ .727	+105	− .0036	− .06
5563	+ .0067	1.0	− .724	+202	+ .0007	+ .01
5574	+ .0084	1.0	− .735	+203	− .0010	− .02
6779	+ .0119	1.0	+ .881	+454	+ .0010	+ .02
6780	+ .0120	0.9	+ .881	+454	+ .0009	+ .02
6781	+ .0156	0.9	+ .881	+454	− .0027	− .05
7348	+ .0082	0.9	− .786	+573	+ .0018	+ .04
7364	+ .0118	0.9	− .797	+574	− .0018	− .04
7365	+ .0125	0.6	− .797	+574	− .0025	− .04
7384	+0.0086	1.0	−0.817	+576	+0.0014	+0.03

± 0″.066 by photography by Russell. The Allegheny result is + 0″.053 ± 0″.009, while spectrographic value of Mt. Wilson is + 0″.024. Mr. Olivier measured the plates and found a parallax + 0″.047 ± 0″.008 with a proper motion in right ascension + 0″.056 where the value from Boss is + 0″.034.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−60.9	−34.0	+0.2508
2	.10	−19.3	+27.2	.3013
3	.16	+19.5	−30.2	.1945
4	.14	+60.7	+37.0	+0.2534
Parallax star	0.14	− 1.9	+ 3.2	

The normal equations are:

$$22.7c + 2.359\mu + 3.7193\pi = + 0.1818 \text{ mm.}$$
$$+ 360.2277\mu - 15.4673\pi = + 0.2486 \text{ mm.}$$
$$+ 11.5048\pi = + 0.0427 \text{ mm.}$$

from which:

$c = + 0.00756$ mm.

$\mu = + 0.00074$ mm. $= + 0''.0153$, or $+ 0''.056$ per year.

$\pi = + 0.00226$ mm. $= + \mathbf{0''.047 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00122 \text{ mm.} = \pm 0''.025.$$

α HERCULIS ($17^h\ 10^m$; $+14°\ 30'$)

The principal star of this well-known double is a variable with a range in magnitude from 3.1 to 3.9, and of spectral type Mb. The companion of magnitude 5.4 is at a distance of 4″.5, but there has been no change in the relative positions since the first measures. The parallax of Jacob with the equatorial is + 0″.050 ± 0″.011, while the Allegheny value is − 0″.025 ± 0″.009. The spectroscopic value of Adams and Joy is + 0″.006. Fifteen of the later plates were measured by Miss France, while the

earlier plates were measured by Mr. Olivier. The McCormick plates gave a parallax of $+ 0''.006 \pm 0''.008$, while the value of the proper motion in right ascension was found to be $- 0''.028$ per year with the corresponding value from Boss of $- 0''.012$.

TABLE 1

PLATES OF α HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
1508	1915 July 24	+1h1	Ol	0.6*
1509	July 24	+1.6	Ol	0.6
2552	1916 Apr. 4	−0.2	M	0.6*
2649	May 7	+0.6	A	0.9
2660	May 14	−0.5	A	0.7
2805	July 7	+0.6	L	1.0†
2817	July 12	+0.5	M	0.9
2818	July 12	+0.9	M	0.7
3806	1917 Mar. 24	−0.4	Ol	0.7
3837	Mar. 31	−0.6	Ol	0.7
3838	Mar. 31	0.0	Ol	0.7
3906	Apr. 22	−1.2	L	0.9
3907	Apr. 22	−0.8	L	0.9
3925	May 1	−1.1	L	0.7
3926	May 1	−0.7	L	0.7
3940	May 9	−0.8	Ol	0.8
4131	June 29	+1.0	Ol, B	0.8
4251	Aug. 10	−0.1	Ol	0.9
5311	1918 Apr. 22	+0.2	A	1.0
5312	Apr. 22	+0.6	A	1.0
5331	Apr. 29	+0.1	A	1.0
5358	May 8	−0.6	A	1.0
5551	July 14	−0.5	A	0.8
5552	July 14	+0.1	A	0.9
5604	Aug. 6	+0.4	A	1.0
5605	Aug. 6	+0.8	A	1.0
5640	Aug. 20	+0.8	A	0.9

* One exposure. † Three exposures.

TABLE 2

REDUCTIONS FOR α HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1508	−0.0061	0.6	−0.683	−665	+0.0024	+0″.04
1509	− .0044	0.6	− .683	−665	+ .0007	+ .01
2552	− .0059	0.6	+ .892	−410	+ .0016	+ .03
2649	− .0032	0.9	+ .523	−377	− .0013	− .02
2660	− .0051	0.7	+ .419	−370	+ .0006	+ .01
2805	− .0042	1.0	− .459	−316	− .0008	− .02
2817	− .0050	0.9	− .532	−311	.0000	.00
2818	− .0005	0.7	− .532	−311	− .0045	− .08
3806	− .0072	0.7	+ .958	− 56	+ .0017	+ .03
3837	− .0048	0.7	+ .921	− 49	− .0008	− .01
3838	− .0090	0.7	+ .921	− 49	+ .0034	+ .06
3906	− .0040	0.9	+ .722	− 27	− .0017	− .03
3907	− .0068	0.9	+ .722	− 27	+ .0011	+ .02
3925	− .0042	0.7	+ .610	− 18	− .0016	− .03
3926	− .0060	0.7	+ .610	− 18	+ .0002	.00
3940	− .0054	0.8	+ .498	− 10	− .0004	− .01
4131	− .0054	0.8	− .332	+ 41	− .0008	− .02
4251	− .0079	0.9	− .866	+ 83	+ .0014	+ .03
5311	− .0051	1.0	+ .724	+338	− .0020	− .04
5312	− .0078	1.0	+ .724	+338	+ .0008	+ .02
5331	− .0068	1.0	+ .639	+345	− .0003	− .01
5358	− .0060	1.0	+ .516	+354	− .0012	− .02
5551	− .0127	0.8	− .553	+421	+ .0050	+ .09
5552	− .0108	0.9	− .553	+421	+ .0031	+ .06
5604	− .0074	1.0	− .828	+444	− .0004	− .01
5605	− .0038	1.0	− .828	+444	− .0040	− .08
5640	−0.0084	0.9	−0.938	+458	+0.0005	+0.01

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−33.9	+30.5	+0.205
2	.16	−14.9	−17.4	.273
3	.08	+18.4	−15.0	.272
4	.08	+30.4	+ 1.9	+0.250
Parallax star	0.15	+ 1.6	− 2.1	

The normal equations are:

$$22.4c + 8.529\mu + 1.7991\pi = -0.1370 \text{ mm.}$$
$$+ 248.2031\mu - 4.0651\pi = -0.1433 \text{ mm.}$$
$$+ 10.7264\pi = -0.0064 \text{ mm.}$$

from which:

$c = -0.00600$ mm.

$\mu = -0.00037$ mm. $= -0''.0076$, or $-0''.028$ per year.

$\pi = +0.00027$ mm. $= +\mathbf{0''.006 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

δ HERCULIS ($17^h\ 10^m$; $+24°\ 57'$)

According to Burnham's General Catalogue 7922, this is a system of the 61 Cygni type, of magnitudes 3.1 and 8.1, the relative change in position being due to the difference in proper motions of the components. The large star is of A type, and has a total proper motion of $0''.155$. The smaller star was not observed in the McCormick series of plates measured by Mr. Mitchell, being cut out by the use of the rotating sector. Leavenworth by the micrometer finds the average value from two determinations to be $+ 0''.040 \pm 0''.011$. Allegheny by photography derives the parallax $+ 0''.029 \pm 0''.007$. The proper motion in right ascension from the plates is $- 0''.022$ while the corresponding value from Boss amounts to $- 0''.024$.

TABLE 1

PLATES OF δ HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
3820	1917 Mar. 25	−0ʰ7	B, L	0.8
3821	Mar. 25	−0.3	L	0.5*
3879	Apr. 13	−0.6	L	0.8
3880	Apr. 13	−0.2	L	0.8
4141	June 30	−0.2	M	0.8
4153	July 1	−0.1	M	0.9
4220	Aug. 1	−0.2	B	0.6
4221	Aug. 1	+0.2	B	0.4*
5249	1918 Mar. 29	−1.0	A	1.0
5305	Apr. 18	−1.4	M	0.8
5306	Apr. 18	−0.9	M	0.9
5625	Aug. 14	0.0	A	0.7*
5638	Aug. 20	+0.2	A	0.5*
5641	Aug. 22	+0.2	A	0.6*
5643	Aug. 23	+0.2	A	0.6*
6565	1919 Feb. 23	−1.5	M	1.0
6566	Feb. 23	−1.0	M	1.0
6616	Mar. 3	−0.8	H	1.0
6617	Mar. 3	−0.4	H	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−27.3	+36.0	+0.223
2	.13	−16.6	−34.2	.220
3	.15	+17.4	−20.6	.268
4	.17	+26.5	+18.8	+0.289
Parallax star	0.17	+ 2.6	+ 0.4	

TABLE 2

REDUCTIONS FOR δ HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3820	−0.0053	0.8	+0.955	−342	−0.0026	−0″.05
3821	− .0089	0.5	+ .955	−342	+ .0010	+ .01
3879	− .0075	0.8	+ .820	−323	− .0005	− .01
3880	− .0108	0.8	+ .820	−323	+ .0028	+ .05
4141	− .0074	0.8	− .344	−245	− .0017	− .03
4153	− .0118	0.9	− .359	−244	+ .0027	+ .05
4220	− .0067	0.6	− .778	−213	− .0029	− .05
4221	− .0111	0.4	− .778	−213	+ .0015	+ .02
5249	− .0091	1.0	+ .936	+ 26	+ .0001	.00
5305	− .0057	0.8	+ .772	+ 47	− .0034	− .06
5306	− .0115	0.9	+ .772	+ 47	+ .0024	+ .05
5625	− .0117	0.7	− .895	+165	+ .0010	+ .02
5638	− .0081	0.5	− .936	+171	− .0027	− .04
5641	− .0091	0.6	− .948	+173	− .0017	− .03
5643	− .0141	0.6	− .953	+174	+ .0033	+ .05
6565	− .0098	1.0	+ .957	+358	− .0001	.00
6566	− .0090	1.0	+ .957	+358	− .0009	− .02
616	− .0110	1.0	+ .983	+366	+ .0011	+ .02
6617	−0.0100	0.9	+0.983	+366	+0.0001	0.00

The normal equations are:

$$14.6c + 3.365\mu + 4.9722\pi = -0.1373 \text{ mm.}$$
$$+ 105.1028\mu + 5.3712\pi = -0.0590 \text{ mm.}$$
$$+ 10.7172\pi = -0.0412 \text{ mm.}$$

from which:

$c = -0.00959$ mm.

$\mu = -0.00029$ mm. $= -0''.0061$, or $-0''.022$ per year.

$\pi = +0.00075$ mm. $= +\mathbf{0''.016 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

β DRACONIS ($17^h\ 28^m$; $+52°\ 22'$)

The only parallax which has been published for this star of magnitude 2.99, of type G and of small proper motion 0″.016 is the spectroscopic value + 0″.014. Mr. Alden measured fourteen of the photographs, and Mr. Mitchell thirteen. A relative

TABLE 1

PLATES OF β DRACONIS

No.	Date.	Hour Angle.	Observers.	Weight.
2535	1916 Mar. 30	−0h.2	A	0.7
2563	Apr. 6	−0.6	A	0.8
2564	Apr. 6	−0.2	A	0.8
2633	May 2	−1.2	A	0.8
2808	July 11	−0.8	Ol	0.5
2875	Aug. 17	−0.2	A	0.8
2876	Aug. 17	+0.1	A	0.8
2895	Aug. 19	−0.1	A	1.0
3748	1917 Mar. 9	−1.2	A	1.0
3843	Apr. 3	−1.1	M	1.0
3857	Apr. 7	−0.3	L	1.0
3866	Apr. 9	−0.9	M	0.8
3867	Apr. 9	−0.4	M	0.8
4210	July 31	−0.3	A	0.9
4211	July 31	0.0	A	0.9
5227	1918 Mar. 26	−0.6	A	0.8
5228	Mar. 26	−0.1	A	1.0
5250	Mar. 29	−0.8	A	1.0
5251	Mar. 29	−0.4	A	1.0
5591	Aug. 5	−0.5	A	0.8
5592	Aug. 5	−0.1	A	0.8
5658	Aug. 26	+0.1	A	0.7
5659	Aug. 27	+0.1	A	0.7
6635	1919 Mar. 5	−1.5	M	0.8
6636	Mar. 5	−1.1	M	1.0
6858	Apr. 8	−1.2	D	1.0
6859	Apr. 8	−0.8	D	1.0

parallax of $-0''.015 \pm 0''.007$ was determined, and a proper motion in right ascension $-0''.024$ while the corresponding value from Boss is $-0''.014$.

TABLE 2

REDUCTIONS FOR β DRACONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
2535	−0.0133	0.7	+0.951	−523	+0.0012	+0″.02
2563	− .0074	0.8	+ .910	−516	− .0047	− .09
2564	− .0113	0.8	+ .910	−516	− .0008	− .01
2633	− .0130	0.8	+ .651	−490	+ .0010	+ .02
2808	− .0147	0.5	− .455	−420	+ .0033	+ .05
2875	− .0104	0.8	− .892	−383	− .0007	− .01
2876	− .0088	0.8	− .892	−383	− .0023	− .04
2895	− .0118	1.0	− .907	−381	+ .0007	+ .01
3748	− .0136	1.0	+ .990	−179	+ .0004	+ .01
3843	− .0146	1.0	+ .931	−154	+ .0014	+ .03
3857	− .0104	1.0	+ .905	−150	− .0028	− .06
3866	− .0165	0.8	+ .891	−148	+ .0033	+ .06
3867	− .0133	0.8	+ .891	−148	+ .0001	.00
4210	− .0160	0.9	− .722	− 35	+ .0036	+ .07
4211	− .0112	0.9	− .722	− 35	− .0012	− .02
5227	− .0139	0.8	+ .973	+203	− .0005	− .01
5228	− .0136	1.0	+ .973	+203	− .0008	− .02
5250	− .0152	1.0	+ .959	+206	+ .0008	+ .02
5251	− .0164	1.0	+ .959	+206	+ .0020	+ .04
5591	− .0145	0.8	− .776	+335	+ .0010	+ .02
5592	− .0122	0.8	− .776	+335	− .0013	− .02
5658	− .0130	0.7	− .949	+356	− .0004	− .01
5659	− .0120	0.7	− .954	+357	− .0014	− .02
6635	− .0118	0.8	+ .981	+547	− .0036	− .07
6636	− .0177	1.0	+ .981	+547	+ .0022	+ .05
6858	− .0136	1.0	+ .902	+581	− .0019	− .04
6859	−0.0166	1.0	+0.902	+581	+0.0011	+0.02

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−27.5	−37.9	+0.2553
2	.16	−27.6	+25.9	.2290
3	.08	+ 6.1	−36.3	.2673
4	.18	+49.0	+48.3	+0.2484
Parallax star	0.16	+ 0.5	− 1.4	

The normal equations are:

$$23.2c + 3.888\mu + 7.6983\pi = -0.3086 \text{ mm.}$$
$$+ 312.3368\mu + 8.8508\pi = -0.1554 \text{ mm.}$$
$$+ 18.5046\pi = -0.1165 \text{ mm.}$$

from which:

$c = -0.01301$ mm.
$\mu = -0.00031$ mm. $= -0''.0065$, or $-0''.024$ per year.
$\pi = -0.00074$ mm. $= -\mathbf{0''.015 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

β OPHIUCHI ($17^h\ 38^m$; $+4°\ 36'$)

By photography, the Allegheny Observatory has measured the parallax of this star, and found the result $+ 0''.018 \pm 0''.009$. The spectroscopic value of Mt. Wilson is $+ 0''.023$. The magnitude is 2.94, the type K, and the total proper motion $0''.158$. Fifteen of the McCormick plates were measured by Mr. Mitchell, the balance by Mr. Briggs, with a relative parallax found of $+ 0''.021 \pm 0''.010$, a result in good agreement with Allegheny and Mt. Wilson. The proper motion from the plates in right ascension is $- 0''.029$ while the corresponding value from Boss is $- 0''.041$.

TABLE 1

PLATES OF β OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
1076	1915 Mar. 17	$-0^h.7$	G	0.7
1110	Mar. 24	−0.6	G	0.5
1177	Apr. 9	−0.4	A	0.5
1448	July 9	−0.1	A	0.8
1449	July 9	+0.5	A	0.5
1491	July 18	+0.5	G	0.4*
1492	July 18	+1.0	G	0.4*
3887	1917 Apr. 16	−0.5	A	0.6*
3960	May 14	−0.9	Ol	0.8
3961	May 14	−0.5	Ol	0.8
4173	July 13	+0.6	Ol	0.8
4174	July 13	+1.0	Ol	0.8
4239	Aug. 5	0.0	B	0.7
4240	Aug. 5	+0.4	B	0.7
5359	1918 May 9	−0.3	Ol	1.0
5360	May 9	+0.3	Ol	1.0
5366	May 14	−0.8	Ol	0.8
5367	May 14	−0.4	Ol	0.8
5642	Aug. 22	+0.4	A	1.0
5668	Sept. 1	+0.3	A	0.8
5669	Sept. 1	+0.6	A	0.8
6687	1919 Mar. 12	−1.0	H	1.0
6739	Mar. 23	−1.4	D	1.0
6740	Mar. 23	−0.9	D	1.0
6792	Mar. 30	−0.6	F	1.0
6793	Mar. 30	−0.1	F	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR β OPHIUCHI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1076	−0.0383	0.7	+0.995	−847	−0.0022	−0″.04
1110	− .0379	0.5	+ .994	−840	− .0026	− .04
1177	− .0388	0.5	+ .938	−824	− .0019	− .03
1448	− .0434	0.8	− .315	−733	+ .0011	+ .02
1449	− .0437	0.5	− .315	−733	+ .0014	+ .02
1491	− .0406	0.4	− .456	−724	− .0018	− .02
1492	− .0397	0.4	− .456	−724	− .0028	− .04
3887	− .0473	0.6	+ .887	− 86	+ .0039	+ .06
3960	− .0477	0.8	+ .579	− 58	+ .0038	+ .07
3961	− .0460	0.8	+ .579	− 58	+ .0021	+ .04
4173	− .0458	0.8	− .387	+ 2	+ .0007	+ .01
4174	− .0459	0.8	− .387	+ 2	+ .0008	+ .01
4239	− .0478	0.7	− .708	+ 25	+ .0023	+ .04
4240	− .0460	0.7	− .708	+ 25	+ .0005	+ .01
5359	− .0490	1.0	+ .648	+302	+ .0038	+ .08
5360	− .0435	1.0	+ .648	+302	− .0017	− .04
5366	− .0473	0.8	+ .582	+307	+ .0020	+ .04
5367	− .0402	0.8	+ .582	+307	− .0051	− .10
5642	− .0486	1.0	− .878	+407	+ .0014	+ .03
5668	− .0430	0.8	− .948	+417	− .0043	− .08
5669	− .0459	0.8	− .948	+417	− .0014	− .02
6687	− .0433	1.0	+ .987	+609	− .0027	− .06
6739	− .0480	1.0	+ .995	+620	+ .0019	+ .04
6740	− .0437	1.0	+ .995	+620	− .0024	− .05
6792	− .0446	1.0	+ .981	+627	− .0015	− .03
6793	−0.0484	1.0	+0.981	+627	+0.0023	+0.05

The normal equations are:

$$20.2c + 22.092\mu + 5.5078\pi = -0.9064 \text{ mm.}$$
$$+ 502.6009\mu + 17.9736\pi = -1.1606 \text{ mm.}$$
$$+ 12.3417\pi = -0.2407 \text{ mm.}$$

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−53.9	−29.4	+0.197
2	.13	−26.6	+41.8	.170
3	.11	+15.4	−40.8	.226
4	.10	+21.2	+41.0	.186
5	.12	+43.9	−12.6	+0.221
Parallax star	0.15	+ 1.9	− 3.0	

from which:

$c = -0.04473$ mm.
$\mu = -0.00038$ mm. $= -0''.0079$, or $-0''.029$ per year.
$\pi = +0.00101$ mm. $= +\mathbf{0''.021 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00159 \text{ mm.} = \pm 0''.033.$$

μ HERCULIS ($17^h\ 42^m$; $+27°\ 47'$)

This star, of magnitude 3.48 and type G5 is the brighter star of the well-known system. It has a total proper motion $0''.817$ per year, which is shared by the companions BC, so that all three stars form a physical system. The parallax of the brighter star has been several times determined, as follows: Chase with Yale heliometer, $+0''.122 \pm 0''.038$; Russell by photography found the value for the principal star, $+0''.024 \pm 0''.028$, and for the companions BC the value $+0''.051 \pm 0''.049$; Flint by meridian circle obtained $+0''.126 \pm 0''.022$; while Jewdokimov, also by meridian circle found $+0''.093 \pm 0''.070$. The Allegheny value by photography is $+0''.104 \pm 0''.008$. Adams by the spectrograph found the parallax $+0''.132$. Mr. Mitchell measured the McCormick plates and found a parallax of $+0''.108 \pm 0''.009$. With the McCormick value of the parallax and Aitken's orbit (*Lick Observatory Publications*, **12**, 119), the mass of the system BC is 0.81 ⊙.

TABLE 1

PLATES OF μ HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
3927	1917 May 1	$-0^h.7$	L	0.7
3928	May 1	−0.4	L	0.7
3948	May 12	−1.3	Ol	0.7
3949	May 12	−0.9	Ol	0.7
4012	May 25	−0.2	Ol	0.7
4237	Aug. 5	−0.9	B	0.7
4238	Aug. 5	−0.6	B	0.7
4258	Aug. 12	−0.5	B	0.5
4259	Aug. 12	−0.2	B	0.4*
5298	1918 Apr. 15	−1.2	A	1.0
5299	Apr. 15	−0.8	A	1.0
5337	May 1	−1.3	A	0.9
5338	May 1	−0.9	A	1.0
5629	Aug. 19	+0.1	A	1.0
5645	Aug. 23	+0.2	A	1.0
5660	Aug. 27	+0.2	A	1.0
6669	1919 Mar. 1	−1.2	Ol	1.0
6670	Mar. 1	−0.8	Ol	0.9
6706	Mar. 20	−1.3	D	0.8
6707	Mar. 20	−0.9	D	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−43.3	+16.4	+0.232
2	.10	−35.3	+25.2	.247
3	.10	+31.2	−54.0	.223
4	.13	+47.4	+12.4	+0.298
Parallax star	0.13	+ 2.4	+ 1.7	

TABLE 2

REDUCTIONS FOR μ HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3927	+0.0022	0.7	+0.711	−301	+0.0001	0″.00
3928	+ .0020	0.7	+ .711	−301	+ .0003	.00
3948	+ .0014	0.7	+ .569	−290	− .0002	.00
3949	− .0019	0.7	+ .569	−290	+ .0031	+ .05
4012	+ .0030	0.7	+ .375	−277	− .0033	− .06
4237	− .0111	0.7	− .739	−205	+ .0026	+ .05
4238	− .0079	0.7	− .739	−205	− .0006	− .01
4258	− .0090	0.5	− .814	−198	− .0002	.00
4259	− .0117	0.4	− .814	−198	+ .0026	+ .03
5298	− .0076	1.0	+ .875	+ 48	− .0011	− .02
5299	− .0103	1.0	+ .875	+ 48	+ .0016	+ .03
5337	− .0086	0.9	+ .714	+ 64	− .0015	− .03
5338	− .0077	1.0	+ .714	+ 64	− .0024	− .05
5629	− .0196	1.0	− .876	+174	− .0025	− .05
5645	− .0236	1.0	− .907	+178	+ .0012	+ .02
5660	− .0226	1.0	− .934	+182	− .0001	.00
6669	− .0174	1.0	+ .955	+368	− .0018	− .04
6670	− .0197	0.9	+ .955	+368	+ .0006	+ .01
6706	− .0193	0.8	+ .994	+387	− .0003	− .01
6707	−0.0251	0.7	+0.994	+387	+0.0055	+0.10

The normal equations are:

$$16.1c + 5.448\mu + 3.9824\pi = -0.1851 \text{ mm.}$$
$$+ 98.1844\mu + 6.8552\pi = -0.3610 \text{ mm.}$$
$$+ 10.7975\pi = -0.0134 \text{ mm.}$$

from which:

$c = -0.01163$ mm.

$\mu = -0.00339$ mm. $= -0''.0706$, or $-0''.258$ per year.

$\pi = +0.00521$ mm. $= +\mathbf{0''.108 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

ν OPHIUCHI ($17^h\ 53^m$; $-9°\ 45'$)

This is a star of K type, of magnitude 3.50, and of small total proper motion 0″.12 per year. The spectroscopic parallax of Adams and Joy is + 0″.019. The twenty plates of the series were measured by Mr. Alden, who finds a proper motion in right ascension of + 0″.011 per year. The value of Boss is − 0″.012 per year.

TABLE 1

PLATES OF ν OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
1161	1915 Apr. 7	−0^{h}5	A	0.7
1291	May 9	−1.1	A	1.0
1292	May 9	−0.5	A	1.0
1469	July 16	+0.3	A	0.8
1480	July 17	+0.4	A	1.0
1481	July 17	+1.0	A	1.0
2634	1916 May 2	−1.0	A	0.9
2849	Aug. 7	+0.7	Ol	0.4*
2977	Sept. 9	+0.6	M	0.7
3898	1917 Apr. 18	+0.2	A	0.9
3899	Apr. 18	+0.4	A	0.7*
3950	May 12	+0.5	Ol	0.8
3962	May 14	−0.1	Ol	0.5
3973	May 18	−0.8	Ol	0.9
3974	May 18	−0.3	Ol	0.8
4291	Aug. 19	+0.6	A	1.0
4292	Aug. 19	+1.1	A	1.0
4334	Aug. 25	+0.3	A	0.8
4335	Aug. 25	+0.9	A	0.8
4363	Aug. 28	+0.3	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−46.4	− 3.8	+0.2056
2	.10	−38.9	−23.5	.2051
3	.12	−24.3	+39.4	.2021
4	.16	+55.6	+44.3	.1925
5	.10	+54.0	−56.4	+0.1947
Parallax star	0.18	− 1.2	− 0.1	

TABLE 2

REDUCTIONS FOR ν OPHIUCHI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1161	+0.0098	0.7	+0.949	−534	−0.0036	−0″.06
1291	+ .0032	1.0	+ .652	−502	+ .0028	+ .06
1292	+ .0060	1.0	+ .652	−502	.0000	.00
1469	+ .0033	0.8	− .425	−434	+ .0015	+ .03
1480	+ .0068	1.0	− .441	−433	− .0020	− .04
1481	+ .0039	1.0	− .441	−433	+ .0009	+ .02
2634	+ .0068	0.9	+ .728	−143	− .0002	.00
2849	+ .0048	0.4	− .735	− 46	+ .0002	.00
2977	+ .0054	0.7	− .985	− 13	− .0006	− .01
3898	+ .0026	0.9	+ .870	+208	+ .0046	+ .09
3899	+ .0043	0.7	+ .870	+208	+ .0030	+ .05
3950	+ .0106	0.8	+ .605	+232	− .0036	− .07
3962	+ .0105	0.5	+ .578	+234	− .0036	− .05
3973	+ .0093	0.9	+ .522	+238	− .0024	− .05
3974	+ .0071	0.8	+ .522	+238	− .0002	.00
4291	+ .0075	1.0	− .855	+331	− .0021	− .04
4292	+ .0051	1.0	− .855	+331	+ .0003	+ .01
4334	+ .0033	0.8	− .904	+337	+ .0021	+ .04
4335	+ .0039	0.8	− .904	+337	+ .0015	+ .03
4363	+0.0054	1.0	−0.925	+340	0.0000	0.00

The normal equations are:

$$16.7c - 1.660\mu - 0.6110\pi = + 0.0981 \text{ mm.}$$
$$+ 200.1036\mu - 12.3838\pi = + 0.0053 \text{ mm.}$$
$$+ 9.1457\pi = + 0.0052 \text{ mm.}$$

from which:

$c = + 0.00593$ mm.

$\mu = + 0.00015$ mm. $= + 0''.0031$ per year.

$\pi = + 0.00116$ mm. $= + \mathbf{0''.024 \pm 0''.011}$.

Probable error of plate of unit weight

± 0.00147 mm. $= \pm 0''.031$.

BARNARD'S STAR OF LARGE PROPER MOTION
($17^h\ 54^m$; $+4°\ 25'$)

This star has the distinction of having the largest proper motion at present known, $10''.3$ per year. It is of magnitude 9.7, and of type Mb. The plates were measured by Mr. Mitchell, and a relative parallax, $+ 0''.539 \pm 0''.008$ resulted, with a proper motion in right ascension $- 0''.715$ per year. Other photographic determinations of the parallax published are:

Observatory.	Instrument.	Parallax.
Dearborn	18½-in. refractor	$+0''.557 \pm 0''.016$
Mt. Wilson	60-in. reflector	$+ .519 \pm .006$
Yerkes	40-in. refractor	$+ .509 \pm .006$

The value of the McCormick parallax gives for this star an absolute visual magnitude 13.38, making it one of the smallest objects known to astronomy outside of the solar system.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−24.2	+22.9	+0.245
2	.16	−10.4	− 5.3	.237
3	.12	− 1.4	−38.7	.250
4	.15	+19.0	− 1.6	.145
5	.11	+17.0	+22.7	+0.123
Parallax star	0.15	− 3.91	− 2.78	

TABLE 1

PLATES OF BARNARD'S STAR

No.	Date.	Hour Angle.	Observers.	Weight.
2911	1916 Aug. 20	+0^{h}3	A	0.9
2912	Aug. 20	+0.9	A	0.9
2916	Aug. 25	−0.2	A	1.0
2917	Aug. 25	+0.5	A	1.0
2951	Sept. 3	+0.5	M	1.0
3794	1917 Mar. 22	−1.2	M	0.9
3807	Mar. 24	−0.6	Ol	0.7
3829	Mar. 29	−0.8	M	0.8
3830	Mar. 29	−0.4	M	0.9
3844	Apr. 3	−1.0	M	0.8
3845	Apr. 3	−0.5	M	0.6*
3860	Apr. 7	−0.4	L	1.0
3861	Apr. 7	0.0	L	1.0
3896	Apr. 18	−0.8	A	1.0
3897	Apr. 18	−0.5	A	0.8
4212	July 31	+0.2	A	0.8
4213	July 31	+0.6	A	0.9
4301	Aug. 20	−0.2	A	0.9
4302	Aug. 20	+0.3	A	1.0
4355	Aug. 27	+0.3	B	1.0
4356	Aug. 27	+0.7	B	1.0
5212	1918 Mar. 18	−0.9	A	1.0
5252	Mar. 29	−0.2	A	1.0
5290	Apr. 14	+0.2	Ol	1.0
5291	Apr. 14	+0.6	Ol	0.7
5301	Apr. 15	+0.2	A	1.0
5594	Aug. 5	+0.7	A	1.0
5646	Aug. 23	+0.5	A	0.8
5647	Aug. 23	+0.9	A	1.0
5670	Sept. 1	+0.9	A	0.8

* One exposure.

TABLE 2

REDUCTIONS FOR BARNARD'S STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2911	−0.0404	0.9	−0.868	−345	+0.0010	+0″.02
2912	− .0410	0.9	− .868	−345	+ .0016	+ .03
2916	− .0418	1.0	− .907	−340	+ .0010	+ .02
2917	− .0417	1.0	− .907	−340	+ .0008	+ .02
2951	− .0458	1.0	− .962	−331	+ .0027	+ .06
3794	− .0128	0.9	+ .995	−131	+ .0016	+ .03
3807	− .0142	0.7	+ .993	−129	+ .0027	+ .05
3829	− .0112	0.8	+ .982	−124	− .0010	− .02
3830	− .0131	0.9	+ .982	−124	+ .0009	+ .02
3844	− .0152	0.8	+ .964	−119	+ .0020	+ .04
3845	− .0111	0.6	+ .964	−119	− .0021	− .03
3860	− .0112	1.0	+ .944	−115	− .0029	− .06
3861	− .0120	1.0	+ .944	−115	− .0021	− .04
3896	− .0156	1.0	+ .869	−104	− .0014	− .03
3897	− .0156	0.8	+ .869	−104	− .0014	− .03
4212	− .0600	0.8	− .648	− 0	− .0062	− .11
4213	− .0656	0.9	− .648	− 0	− .0006	− .01
4301	− .0682	0.9	− .866	+ 20	− .0055	− .11
4302	− .0710	1.0	− .866	+ 20	− .0027	− .06
4355	− .0778	1.0	− .919	+ 27	+ .0021	+ .04
4356	− .0769	1.0	− .919	+ 27	+ .0012	+ .02
5212	− .0436	1.0	+ .996	+230	− .0016	− .03
5252	− .0522	1.0	+ .982	+241	+ .0056	+ .12
5290	− .0538	1.0	+ .901	+257	+ .0036	+ .07
5291	− .0492	0.7	+ .901	+257	− .0010	− .02
5301	− .0483	1.0	+ .894	+258	− .0022	− .05
5594	− .1026	1.0	− .708	+370	+ .0000	.00
5646	− .1072	0.8	− .888	+388	− .0017	− .03
5647	− .1090	1.0	− .888	+388	+ .0001	.00
5670	−0.1156	0.8	−0.949	+397	+ .0042	+0.08

The normal equations are:

$$27.2c + 0.091\mu + 0.4765\pi = -1.3311 \text{ mm.}$$
$$150.000\mu + 3.4379\pi = -1.3280 \text{ mm.}$$
$$22.1947\pi = +0.5194 \text{ mm.}$$

from which:

$c = -0.04936$ mm.
$\mu = -0.00941$ mm. $= -0''.1959$ or, $-0''.715$ per year.
$\pi = +0.02592$ mm. $= +\mathbf{0''.539 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00175 \text{ mm.} = \pm 0''.036.$$

γ DRACONIS ($17^h\ 54^m$; $+51°\ 30'$)

This is a star of 2.42 magnitude, and of K5 type, with small annual proper motion amounting to $0''.03$. Its parallax has been many times investigated, but the earlier results are in general discordant. Some of the more recent values of the parallax are as follows:

Parallax.	Authority.	Method.
$+0''.050 \pm 0''.028$	Pritchard	Photography
$+ .10 \pm .02$	Kostinsky	Photography
$+ .002 \pm .021$	Flint	Meridian circle
$- .022 \pm .058$	Jewdokimov	Meridian circle
$+ .011 \pm .008$	Allegheny	Photography
$+0''.030$	Adams	Spectrograph

Mr. Olivier measured the McCormick series of plates, and determined a relative parallax of $0''.000 \pm 0''.006$, with a proper motion in right ascension of $+ 0''.028$ while the value from Boss is $- 0''.008$.

TABLE 1

PLATES OF γ DRACONIS

No.	Date.	Hour Angle.	Observers.	Weight.
1171	1915 Apr. 8	−0^{h}4	G	1.0
1195	Apr. 13	−0.6	Ol	0.7*
1246	Apr. 24	−0.6	M	1.0
1523	Aug. 6	−0.2	Ol	0.6
1536	Aug. 7	−1.0	Ol	0.9
2487	1916 Mar. 15	−1.2	Ol	0.6*
2588	Apr. 20	−1.4	Ol	1.0
2589	Apr. 20	−0.8	Ol	0.9
2847	Aug. 7	−0.8	Ol	0.6*
2848	Aug. 7	−0.4	Ol	1.0
2887	Aug. 18	−0.1	Ol	0.9
2913	Aug. 21	−0.1	Ol	0.9
5288	1918 Apr. 14	−1.0	Ol	1.0
5289	Apr. 14	−0.4	Ol	0.9
5324	Apr. 27	−1.3	Ol	1.0
5325	Apr. 27	−0.7	Ol	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−47.3	− 4.8	+0.3349
2	.09	−25.8	−19.1	.2509
3	.14	+26.5	− 3.2	.1863
4	.10	+46.6	+27.1	+0.2279
Parallax star	0.16	− 6.8	− 0.8	

TABLE 2

REDUCTIONS FOR γ DRACONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1171	−0.0056	1.0	+0.943	−485	−0.0015	−0″.03
1195	− .0040	0.7	+ .911	−480	+ .0001	.00
1246	− .0018	1.0	+ .821	−469	+ .0022	+ .05
1523	− .0036	0.6	− .714	−365	+ .0001	.00
1536	− .0057	0.9	− .725	−364	− .0020	− .04
2487	− .0041	0.6	+ .933	−143	− .0012	− .02
2588	− .0034	1.0	+ .852	−107	− .0007	− .01
2589	− .0011	0.9	+ .852	−107	+ .0016	+ .03
2847	− .0039	0.6	− .734	+ 2	− .0016	− .02
2848	− .0016	1.0	− .734	+ 2	+ .0007	+ .01
2887	− .0017	0.9	− .848	+ 13	+ .0006	+ .01
2913	− .0011	0.9	− .874	+ 16	+ .0012	+ .02
5288	− .0013	1.0	+ .903	+617	− .0012	− .02
5289	+ .0002	0.9	+ .903	+617	+ .0003	.00
5324	+ .0008	1.0	+ .789	+630	+ .0008	+ .02
5325	−0.0004	1.0	+0.789	+630	−0.0004	−0.01

The normal equations are:

$$14.0c + 3.359\mu + 4.0699\pi = -0.0315 \text{ mm.}$$
$$+ 236.7168\mu + 10.1998\pi = +0.0790 \text{ mm.}$$
$$+ 9.8157\pi = -0.0057 \text{ mm.}$$

from which:

$c = -0.00234$ mm.

$\mu = +0.00037$ mm. $= +0''.0076$, or $+0''.028$ per year.

$\pi = +0.00001$ mm. $= \mathbf{0''.000 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00085 \text{ mm.} = \pm 0''.018.$$

70 OPHIUCHI ($18^h\ 0^m$; $+2°\ 31'$)

This binary system is of more than usual interest. It is one of the best known and most frequently observed doubles; it has a period of 88 years, and has completed one revolution since its discovery. It has a large proper motion of $1''.13$ per year, and a rather large parallax. According to Campbell, L. O. B., **5**, 63, 1908, the radial velocity of the center of mass is -7.4 km. The components are of 4.1 and 6.0 magnitudes with a distance of about $4''$. An attempt was made to determine the parallax

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−41.0	−23.2	+0.212
2	.12	−35.2	+35.0	.240
3	.10	+36.8	−29.5	.263
4	.13	+39.4	+17.7	+0.285
Principal star	.22	+ 3.7	+ 0.9	
Companion	0.12	+ 3.8	+ 0.7	

of both components. The rotating sector was used, and was opened so that the fainter star could be well seen on the photographs. This had the result of causing the principal star to be larger on the photographs than would ordinarily be used for parallax determinations.

A value of the parallax of this star has been published in the *Astrophysical Journal*, **42**, 263, 1915, the values being obtained from plates taken in three seasons only. Plates at two additional seasons were secured. The whole series of plates were measured by Mr. Mitchell.

TABLE 1

PLATES OF 70 OPHIUCHI

No.	Date.	Hour Angle.	Observers.	Weight.
1	1914 May 2	+0h4	M	1.0
6	May 9	−0.4	M	0.9
7	May 9	+0.2	M	1.0
10	May 10	+0.3	M	0.9
13	May 11	−1.5	M	0.9
216	Sept. 6	+1.1	M	0.6
249	Sept. 15	+0.6	M	0.9
353	Sept. 30	+1.3	M	0.9
365	Oct. 1	+1.3	M, Ol	0.7
1120	1915 Mar. 27	−0.5	G	1.0
1183	Apr. 12	−1.0	M	0.7
1203	Apr. 14	−0.9	A	1.0
1213	Apr. 15	−0.9	M	0.9
3845	1917 Apr. 3	−0.4	M	0.8
3908	Apr. 22	−0.8	L	0.9
3909	Apr. 22	−0.3	L	1.0
3996	May 23	−0.8	M	0.7
3997	May 23	−0.3	M	0.8
4278	Aug. 13	−0.4	B	0.9
4279	Aug. 13	+0.1	B	0.9
4322	Aug. 24	−0.2	Ol	0.9
4323	Aug. 24	+0.3	Ol	0.8

TABLE 2

REDUCTIONS FOR 70 OPHIUCHI, PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1	−0.0490	1.0	+0.752	−549	+0.0004	+0″.01
6	− .0486	0.9	+ .670	−542	− .0006	− .01
7	− .0492	1.0	+ .670	−542	.0000	.00
10	− .0500	0.9	+ .657	−541	+ .0007	+ .01
13	− .0474	0.9	+ .644	−540	− .0020	− .04
216	− .0578	0.6	− .980	−419	− .0029	− .05
249	− .0582	0.9	− .995	−413	− .0025	− .05
353	− .0600	0.9	− .994	−398	− .0004	− .01
365	− .0624	0.7	− .992	−397	+ .0020	+ .04
1120	− .0442	1.0	+ .992	−220	+ .0035	+ .07
1183	− .0406	0.7	+ .930	−204	− .0003	− .01
1203	− .0432	1.0	+ .917	−202	+ .0022	+ .05
1213	− .0418	0.9	+ .910	−201	+ .0008	+ .01
3845	− .0244	0.8	+ .922	+518	− .0032	− .06
3908	− .0296	0.9	+ .850	+537	+ .0014	+ .03
3909	− .0260	1.0	+ .850	+537	− .0022	− .05
3996	− .0306	0.7	+ .473	+568	− .0002	.00
3997	− .0280	0.8	+ .473	+568	− .0028	− .05
4278	− .0394	0.9	− .831	+655	− .0007	− .01
4279	− .0416	0.9	− .831	+655	+ .0015	+ .03
4322	− .0422	0.9	− .883	+661	+ .0018	+ .04
4323	−0.0425	0.8	−0.883	+661	+0.0021	+0.04

The normal equations are:

$$19.1c + 0.328\mu + 3.6076\pi = -0.8286 \text{ mm.}$$
$$+ 481.3347\mu - 14.8758\pi = +0.7287 \text{ mm.}$$
$$+ 13.4338\pi = -0.0775 \text{ mm.}$$

from which:

$c = -0.04498$ mm.

$\mu = +0.00180$ mm. $= +0''.0375$, or $+0''.137$ per year.

$\pi = +0.00831$ mm. $= +$ **0″.173 ± 0″.007.**

Probable error corresponding to unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

TABLE 3

REDUCTIONS FOR 70 OPHIUCHI, COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1	+0.0768	1.0	+0.752	−549	0.0000	0″.00
6	+ .0808	0.9	+ .670	−542	− .0043	− .09
7	+ .0777	1.0	+ .670	−542	− .0012	− .02
10	+ .0762	0.9	+ .657	−541	+ .0002	.00
13	+ .0772	0.9	+ .644	−540	− .0009	− .02
216	+ .0678	0.6	− .980	−419	+ .0003	.00
249	+ .0682	0.9	− .995	−413	+ .0001	.00
353	+ .0694	0.9	− .994	−398	− .0003	− .01
365	+ .0681	0.7	− .992	−397	+ .0010	+ .02
1120	+ .0928	1.0	+ .992	−220	+ .0029	+ .06
1183	+ .0974	0.7	+ .930	−204	− .0015	− .02
1203	+ .0934	1.0	+ .917	−202	+ .0025	+ .05
1213	+ .0925	0.9	+ .910	−201	+ .0034	+ .07
3845	+ .1308	0.8	+ .972	+518	+ .0022	+ .04
3908	+ .1295	0.9	+ .850	+537	+ .0033	+ .07
3909	+ .1356	1.0	+ .850	+537	− .0028	− .06
3996	+ .1338	0.7	+ .473	+568	− .0027	− .05
3997	+ .1362	0.8	+ .473	+568	− .0051	− .10
4278	+ .1244	0.9	− .831	+655	− .0004	− .01
4279	+ .1244	0.9	− .831	+655	− .0004	− .01
4322	+ .1238	0.9	− .883	+661	.0000	.00
4323	+0.1208	0.8	−0.883	+661	+0.0030	+0.06

The normal equations are:

$$19.1c + 0.328\mu + 3.6076\pi = + 1.9065 \text{ mm.}$$
$$+ 481.3347\mu - 14.8758\pi = + 2.3448 \text{ mm.}$$
$$+ 13.4338\pi = + 0.3970 \text{ mm.}$$

from which:

$c = + 0.09806$ mm.

$\mu = + 0.00508$ mm. $= + 0''.1056$, or $+ 0''.385$ per year.

$\pi = + 0.00884$ mm. $= \mathbf{+ 0''.184 \pm 0''.009}$.

Probable error corresponding to unit weight

$$\pm 0.00156 \text{ mm.} = \pm 0''.032.$$

Since these two components form a physical system, the values of the parallaxes should be the same. Combining the two results obtained above, with weights depending on the probable errors, the parallax of the system is:

$$+ 0''.177 \pm 0''.006.$$

Other determinations of the parallax of this system are:

Authority.	Method.	Principal Star A	Center of Gravity $\frac{AB}{2}$
Krueger	Heliometer		+0″.156±0″.010
Schur	Heliometer		+ .286± .031
Jewdokimov	Meridian Circle		+ .279± .105
Flint	Meridian Circle	+0″.19 ±0″.029	
Slocum	Photography .	+0.212±0.007	
Schlesinger	Photography	+0.184±0.009	
Miller	Photography	+0.181±0.009	

The present series of photographs gives the only value of the parallax of the fainter component so far published. It is to the measures of the fainter component that we owe additional information regarding this interesting system.

The equations for 70 Ophiuchi might have been solved by allowing for the orbital motion. The photographs, however, were all taken in a comparatively short interval of time, and in this period of time, the above reductions assumed that the orbital motion was linear, or in other words, proportional to the time. Allowance for the orbital motion would have made no appreciable difference in the values of the parallax, but would have brought the two values of the proper motion of the two components into agreement with the proper motion of the system. It is this difference of proper motion which permits us to obtain the ratios of the masses of the two components, A and B. Assuming the value of the proper motion of the system, $\mu\alpha \cos \delta = + 0''.253$ as given by Boss in the Preliminary General Catalogue (resulting from meridian circle observations which stretch over more than a

whole period of the system), then we readily find that the ratios of the masses

$$B/A = 0.88$$

In *Astronomical Journal* **32**, 153, 1920, Comstock finds the proper motion of the center of gravity + 0″.246 in right ascension. Assuming this value, then the above measures give

$$\mathbf{B/A = 0.79.}$$

According to Comstock, "eight nearly independent determinations of the mass ratio of the components of 70 Ophiuchi give B/A = 0.79."

Assuming a period of 87.9 years, and semi-major axis of 4″.56, then we find the mass of the system is 1.67 times that of the sun.

99 HERCULIS ($18^h\ 3^m$; +30° 33′)

This is a visual binary of magnitudes 5.2 and 10.5. The principal star is of type F8, and the system has a total proper motion 0″.135. Four determinations of the parallax have been made, as follows: Flint by meridian circle, + 0″.074 ± 0″.022; Adams by spectrograph + 0″.105; and two values by photography, at Allegheny Observatory, + 0″.025 ± 0″.006, and at the Sproul Observatory, + 0″.043 ± 0″.010. Mr. Lamb measured the McCormick plates, and found a relative parallax of + 0″.044 ± 0″.010, with a proper motion in right ascension − 0″.082, while the corresponding value from Boss is − 0″.095.

The most satisfactory orbit computed for the star is that of Lohse (*Publ. d. Astrophys. Obs. zu Potsdam*, **20**, 158, 1908), who found a period of 53.5 years and a value of *a* equal 1″.11. Using Lohse's values, and the McCormick parallax, the mass of the system 99 Herculis is 4.1 times that of the sun.

TABLE 1

PLATES OF 99 HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
1221	1915 Apr. 17	-1^h3	M	0.8
1256	Apr. 26	−0.7	G	0.8
1257	Apr. 26	−0.2	G	0.6*
1498	July 21	−0.4	G	0.8
2932	1916 Aug. 27	−0.4	A	1.0
2933	Aug. 27	0.0	A	1.0
2948	Aug. 31	−0.1	A	0.9
2949	Aug. 31	0.0	A	0.7*
3822	1917 Mar. 25	−0.7	B	0.8
3858	Apr. 7	−1.3	L	1.0
3859	Apr. 7	−1.0	L	1.0
3881	Apr. 13	−0.3	L	0.8
4020	May 29	−0.5	Ol	1.0
4276	Aug. 18	−0.5	B	1.0
4277	Aug. 18	−0.2	B	0.9
4289	Aug. 19	−0.6	A	1.0
4290	Aug. 19	−0.3	A	1.0
5378	1918 May 17	−0.6	A	1.0
5379	May 17	−0.1	A	1.0
5388	May 25	−0.4	Ol	0.8
5389	May 25	0.0	Ol	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−52.4	− 2.3	+0.3511
2	.14	+14.5	−22.6	+0.1296
3	.15	+37.9	+24.9	+0.5193
Parallax star	0.14	+ 3.2	+ 9.2	

TABLE 2

REDUCTIONS FOR 99 HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1221	+0.0128	0.8	+0.900	−649	−0.0029	−0″.05
1256	+ .0073	0.8	+ .824	−640	+ .0024	+ .04
1257	+ .0090	0.6	+ .824	−640	+ .0007	+ .01
1498	+ .0078	0.8	− .466	−554	− .0018	− .03
2932	+ .0008	1.0	− .903	−151	− .0001	.00
2933	− .0005	1.0	− .903	−151	+ .0012	+ .02
2948	− .0002	0.9	− .931	−147	+ .0008	+ .02
2949	+ .0018	0.7	− .931	−147	− .0012	− .02
3822	+ .0047	0.8	+ .995	+ 59	− .0022	− .04
3858	+ .0007	1.0	+ .958	+ 72	+ .0016	+ .03
3859	+ .0032	1.0	+ .958	+ 72	− .0010	− .02
3881	− .0040	0.8	+ .924	+ 78	+ .0061	+ .11
4020	+ .0026	1.0	+ .391	+124	− .0021	− .04
4276	− .0021	1.0	− .824	+205	− .0009	− .02
4277	− .0010	0.9	− .824	+205	− .0020	− .04
4289	− .0080	1.0	− .834	+206	+ .0050	+ .10
4290	− .0016	1.0	− .834	+206	− .0014	− .03
5378	− .0012	1.0	+ .571	+477	− .0018	− .04
5379	− .0013	1.0	+ .571	+477	− .0016	− .03
5388	− .0052	0.8	+ .456	+485	+ .0019	+ .04
5389	−0.0031	0.7	+0.456	+485	−0.0002	0.00

The normal equations are:

$$18.6c + 4.650\mu + 0.6398\pi = + 0.0147 \text{ mm.}$$
$$+ 224.2121\mu - 0.0440\pi = - 0.2378 \text{ mm.}$$
$$+ 11.8985\pi = + 0.0260 \text{ mm.}$$

from which:

$c = + 0.00099$ mm.

$\mu = - 0.00108$ mm. $= - 0''.0225$, or $- 0''.082$ per year.

$\pi = + 0.00213$ mm. $= + \mathbf{0''.044 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00158 \text{ mm.} = \pm 0''.033.$$

SCHJELLERUP 16 ($18^h\ 14^m$; $-5°\ 0'$)

This is a double of magnitudes 7.9 and 9.2 with the components at a distance 2″.3. No other parallax has been determined. Miss Hawes measured the plates and found a parallax $-\ 0''.004 \pm 0''.006$ with a proper motion in right ascension $+\ 0''.094$.

TABLE 1

PLATES OF SCHJELLERUP 16

No.	Date.	Hour Angle.	Observers.	Weight.
4379	1917 Aug. 30	$+0^h.5$	B	0.6*
4386	Sept. 1	+0.1	B	1.0
4387	Sept. 1	+0.4	B	0.7*
5401	1918 May 31	−0.1	A	1.0
5692	Sept. 15	+0.5	M	1.0
5693	Sept. 15	+1.0	M	1.0
6741	1919 Mar. 23	−0.8	D	0.8
6822	Apr. 2	−0.8	H	1.0
6903	Apr. 18	−0.5	D	1.0
6904	Apr. 18	0.0	D	1.0
7446	Aug. 9	0.0	H	0.8
7539	Aug. 23	+1.1	H	1.0
7617	Sept. 3	+0.4	F	0.7
7773	Sept. 24	+0.8	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−16.3	+42.7	+0.279
2	.09	−17.9	−23.2	.276
3	.10	− 6.0	−19.5	.224
4	.15	+10.9	−17.8	.149
5	.20	+29.3	+17.8	+0.072
Parallax star	0.17	− 7.1	− 0.2	

TABLE 2

REDUCTIONS FOR SCHJELLERUP 16

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4379	+0.0008	0.6	−0.903	−450	−0.0001	0″.00
4386	+ .0010	1.0	− .917	−448	− .0002	.00
4387	+ .0009	0.7	− .917	−448	− .0001	.00
5401	+ .0028	1.0	+ .406	−176	+ .0011	+ .02
5692	+ .0052	1.0	− .986	− 69	+ .0003	+ .01
5693	+ .0062	1.0	− .986	− 69	− .0007	− .01
6741	+ .0074	0.8	+ .997	+120	.0000	.00
6822	+ .0088	1.0	+ .987	+130	− .0012	− .02
6903	+ .0084	1.0	+ .912	+146	− .0006	− .01
6904	+ .0070	1.0	+ .912	+146	+ .0008	+ .02
7446	+ .0076	0.8	− .689	+259	+ .0019	+ .04
7539	+ .0080	1.0	− .841	+273	+ .0017	+ .04
7617	+ .0092	0.7	− .927	+284	+ .0006	+ .01
7773	+0.0128	1.0	−1.001	+305	−0.0027	−0.06

The normal equations are:

$$12.6c + 1.564\mu - 3.1002\pi = + 0.0798 \text{ mm.}$$
$$+ 85.1925\mu + 6.3519\pi = + 0.1137 \text{ mm.}$$
$$+ 10.1514\pi = - 0.1310 \text{ mm.}$$

from which:

$c = + 0.00613$ mm.

$\mu = + 0.00124$ mm. $= + 0''.0257$, or $+ 0''.094$ per year.

$\pi = - 0.00019$ mm. $= \mathbf{- 0''.004 \pm 0''.006.}$

Probable error of plate of unit weight

$$\pm 0.00085 \text{ mm.} = \pm 0''.018.$$

χ DRACONIS ($18^h\ 22^m$; $+72°\ 41'$)

This star of 3.69 magnitude and F8 type has a considerable proper motion of 0″.64. Its parallax has been determined three times with the following results: With Yale heliometer, Chase

obtained the parallax $+ 0''.11 \pm 0''.038$; by photography the Greenwich Observatory derived the value $+ 0''.107 \pm 0''.011$. Mr. Olivier measured the McCormick series of plates, and found the annual proper motion in right ascension to be $+ 0''.435$, while the result from Boss is $+ 0''.495$.

TABLE 1

PLATES OF χ DRACONIS

No.	Date.	Hour Angle.	Observers.	Weight.
22	1914 May 17	$-0^h.8$	M	1.0
23	May 17	−0.2	M	0.9
30	May 19	−0.4	M	1.0
203	Sept. 5	0.0	M	0.7
1143	1915 Mar. 31	−0.9	A	0.9
1550	Aug. 14	−0.7	Ol	0.8
1567	Aug. 23	−0.3	Ol	0.9
2602	1916 Apr. 26	−0.5	Ol	0.5
2618	Apr. 29	−1.1	Ol	0.7
2619	Apr. 29	−0.6	Ol	0.6*
2630	May 1	−1.2	Ol	0.9
2631	May 1	−0.6	Ol	0.8
2840	Aug. 4	−0.1	Ol	0.9
2896	Aug. 19	−0.5	Ol	0.8
2897	Aug. 19	0.0	Ol	0.8
2962	Sept. 4	−0.3	Ol	0.6*
3002	Sept. 15	+0.2	Ol	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−42.2	+32.6	+0.2455
2	.08	−41.8	−14.4	.2295
3	.18	+36.8	−20.8	.2565
4	.22	+47.2	+ 2.6	+0.2685
Parallax star	0.23	+ 2.2	+ 0.1	

TABLE 2

REDUCTIONS FOR χ DRACONIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
22	+0.0058	1.0	+0.617	−533	−0.0029	−0″.06
23	+ .0025	0.9	+ .617	−533	+ .0004	+ .01
30	+ .0022	1.0	+ .605	−531	+ .0007	+ .01
203	+ .0012	0.7	− .930	−423	+ .0013	+ .02
1143	+ .0224	0.9	+ .994	−217	+ .0002	.00
1550	+ .0237	0.8	− .728	− 80	− .0007	− .01
1567	+ .0206	0.9	− .824	− 71	+ .0025	+ .05
2602	+ .0478	0.5	+ .857	+176	− .0033	− .05
2618	+ .0471	0.7	+ .830	+179	− .0025	− .04
2619	+ .0432	0.6	+ .830	+179	+ .0014	+ .02
2630	+ .0404	0.9	+ .811	+181	+ .0042	+ .08
2631	+ .0438	0.8	+ .811	+181	+ .0008	+ .01
2840	+ .0476	0.9	− .612	+276	− .0037	− .07
2896	+ .0460	0.8	− .791	+291	− .0020	− .04
2897	+ .0416	0.8	− .791	+291	+ .0024	+ .04
2962	+ .0415	0.6	− .927	+307	+ .0028	+ .04
3002	+0.0469	0.8	−0.981	+318	−0.0022	−0.04

The normal equations are:

$$13.6c - 3.820\mu + 0.4257\pi = + 0.3983 \text{ mm.}$$
$$+ 145.3349\mu - 11.8813\pi = + 0.6644 \text{ mm.}$$
$$+ 8.6236\pi = - 0.0178 \text{ mm.}$$

from which:

$c = + 0.03076$ mm.

$\mu = + 0.00573$ mm. $= + 0''.1192$, or $+ 0''.435$ per year.

$\pi = + 0.00432$ mm. $= + \mathbf{0''.090 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00153 \text{ mm.} = \pm 0''.032.$$

110 HERCULIS ($18^h\ 41^m$; $+20°\ 27'$)

Jost has determined with the meridian circle the parallax of this star to be $+ 0''.057 \pm 0''.022$, and Allegheny by photography $+ 0''.040 \pm 0''.011$, while Adams finds the value with the spectro-

TABLE 1

PLATES OF 110 HERCULIS

No.	Date.	Hour Angle.	Observers.	Weight.
1309	1915 May 13	$-1^h.5$	M	0.8
1566	Aug. 21	+0.2	A	1.0
1592	Aug. 30	+0.2	A	0.9
1593	Aug. 30	+0.7	A	1.0
1682	Sept. 14	−0.1	M	0.8
2636	1916 May 2	−0.6	A	0.9
2637	May 2	−0.1	A	1.2†
2650	May 7	−0.4	A	0.9
2651	May 7	0.0	A	0.9
2873	Aug. 16	0.0	A	1.0
2874	Aug. 16	+0.6	A	0.9
2878	Aug. 17	−0.1	A	0.6
2879	Aug. 17	+0.3	A	0.9
2937	Aug. 30	+0.7	A	1.0
2991	Sept. 10	−0.3	M	1.0
4041	1917 June 7	−0.5	Ol	0.8
4042	June 7	−0.1	Ol	0.8
4047	June 8	−0.3	A	1.0
4190	July 29	−0.5	B	0.8
4191	July 29	−0.1	B	0.8
4234	Aug. 4	−0.4	B	1.1†
4235	Aug. 4	0.0	B	0.8
7799	1919 Sept. 26	+0.1	Ol	1.0
7800	Sept. 26	+0.7	Ol	1.0
7817	Sept. 27	+0.3	D	1.0
7818	Sept. 27	+0.7	D	1.0

† Three exposures.

scope + 0″.060. It is of F5 type, of magnitude, 4.26, and of total proper motion 0″.34. The plates of the series were measured by Mr. Alden, who derives the proper motion in right ascension + 0″.002, while the corresponding value from Boss is − 0″.021.

TABLE 2

REDUCTIONS FOR 110 HERCULIS

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1309	−0.0091	0.8	+0.741	−638	−0.0029	−0″.05
1566	− .0150	1.0	− .752	−538	− .0013	− .03
1592	− .0160	0.9	− .843	−529	− .0006	− .01
1593	− .0203	1.0	− .843	−529	+ .0037	+ .08
1682	− .0182	0.8	− .951	−514	+ .0013	+ .02
2636	− .0134	0.9	+ .845	−283	+ .0018	+ .04
2637	− .0110	1.2	+ .845	−283	− .0006	− .01
2650	− .0103	0.9	+ .797	−278	− .0015	− .03
2651	− .0116	0.9	+ .797	−278	− .0002	.00
2873	− .0171	1.0	− .703	−177	+ .0010	+ .02
2874	− .0165	0.9	− .703	−177	+ .0004	+ .01
2878	− .0125	0.6	− .715	−176	− .0036	− .06
2879	− .0164	0.9	− .715	−176	+ .0003	+ .01
2937	− .0122	1.0	− .850	−163	− .0043	− .09
2991	− .0173	1.0	− .932	−152	+ .0006	+ .01
4041	− .0146	0.8	+ .393	+118	+ .0018	+ .03
4042	− .0140	0.8	+ .393	+118	+ .0012	+ .02
4047	− .0134	1.0	+ .377	+119	+ .0005	+ .01
4190	− .0162	0.8	− .454	+170	+ .0009	+ .02
4191	− .0170	0.8	− .454	+170	+ .0017	+ .03
4234	− .0134	1.1	− .542	+176	− .0021	− .05
4235	− .0199	0.8	− .542	+176	+ .0044	+ .08
7799	− .0157	1.0	− .992	+959	− .0009	− .02
7800	− .0150	1.0	− .992	+959	− .0016	− .03
7817	− .0172	1.0	− .994	+960	+ .0006	+ .01
7818	−0.0167	1.0	−0.994	+960	+0.0001	0.00

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−42.6	−29.6	+0.2294
2	.16	−17.2	− 6.3	.2033
3	.16	−10.4	−21.2	.2285
4	.12	+ 2.9	+33.1	.1506
5	.16	+67.3	+24.0	+0.1882
Parallax star	0.16	− 2.5	− 3.4	

The normal equations are:

$$23.9c + 2.775\mu - 8.2252\pi = -0.3583 \text{ mm.}$$
$$+ 564.5190\mu - 29.2770\pi = -0.1082 \text{ mm.}$$
$$+ 14.2397\pi = +0.1556 \text{ mm.}$$

from which:

$c = -0.01400$ mm.

$\mu = +0.00003$ mm. $= +0''.0006$, or $+0''.002$ per year.

$\pi = +0.00290$ mm. $= +$ **0″.060 ± 0″.009.**

Probable error of plate of unit weight

$$\pm 0.00132 \text{ mm.} = \pm 0''.027.$$

γ LYRÆ ($18^h\ 55^m$; $+32°\ 33'$)

No parallax has been determined for this interesting star in Lyra. It is of magnitude 3.30, of type A, and of small proper motion 0″.007. Mitchell (*Astrophysical Journal*, **30**, 241, 1909), has found it to be a spectroscopic binary. Twelve of the McCormick plates were measured by Mr. Alden, and eleven by Mr. Mitchell. A relative parallax $+ 0''.007 \pm 0''.009$ was found, with a proper motion in right ascension $- 0''.003$ while the corresponding value from Boss is $- 0''.002$.

TABLE 1

PLATES OF γ LYRÆ

No.	Date.	Hour Angle.	Observers.	Weight.
2992	1916 Sept. 10	0^h0	M	0.8
2999	Sept. 12	−0.4	M	1.0
3000	Sept. 12	−0.1	A	1.0
3009	Sept. 17	−0.4	M	1.0
3882	1917 Apr. 13	−0.7	L	0.7
3900	Apr. 19	−1.0	M	1.0
3901	Apr. 19	−0.6	M	1.0
3985	May 19	−0.6	M	0.8
4241	Aug. 5	−0.1	B	0.7
4260	Aug. 12	−0.6	B	0.8
4261	Aug. 12	−0.2	B	1.0
4344	Aug. 26	−0.8	A	1.0
4345	Aug. 26	−0.4	A	1.0
5313	1918 Apr. 22	−0.6	A	1.0
5314	Apr. 22	−0.1	A	0.7*
5341	May 1	−0.8	A	1.0
5380	May 17	−0.2	A	0.7*
5402	May 31	−0.2	A	0.9
5630	Aug. 19	−0.6	A	1.0
5631	Aug. 19	−0.1	A	1.0
5676	Sept. 13	−0.4	M	1.0
5679	Sept. 14	−0.4	M	0.9
5680	Sept. 14	−0.1	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−41.4	−26.8	+0.1842
2	.16	−31.6	+ 6.1	.1813
3	.08	+10.6	−12.1	.2088
4	.08	+14.9	+57.5	.1938
5	.13	+47.5	−24.7	+0.2320
Parallax star	0.15	+ 2.8	− 0.9	

TABLE 2

REDUCTIONS FOR γ LYRÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2992	+0.0156	0.8	−0.908	−402	−0.0030	−0″.06
2999	+ .0124	1.0	− .922	−400	+ .0002	.00
3000	+ .0108	1.0	− .922	−400	+ .0018	+ .04
3009	+ .0122	1.0	− .950	−395	+ .0004	+ .01
3882	+ .0084	0.7	+ .980	−187	+ .0047	+ .08
3900	+ .0133	1.0	+ .957	−181	− .0002	.00
3901	+ .0136	1.0	+ .957	−181	− .0005	− .01
3985	+ .0106	0.8	+ .702	−151	+ .0024	+ .04
4241	+ .0154	0.7	− .508	− 73	− .0028	− .05
4260	+ .0116	0.8	− .605	− 66	+ .0010	+ .02
4261	+ .0127	1.0	− .605	− 66	− .0001	.00
4344	+ .0142	1.0	− .774	− 52	− .0017	− .04
4345	+ .0135	1.0	− .774	− 52	− .0010	− .02
5313	+ .0138	1.0	+ .943	+187	− .0008	− .02
5314	+ .0113	0.7	+ .943	+187	+ .0017	+ .03
5341	+ .0179	1.0	+ .884	+196	− .0050	− .10
5380	+ .0131	0.7	+ .728	+212	− .0002	.00
5402	+ .0108	0.9	+ .548	+226	+ .0020	+ .04
5630	+ .0138	1.0	− .692	+306	− .0014	− .03
5631	+ .0154	1.0	− .692	+306	− .0030	− .06
5676	+ .0078	1.0	− .925	+331	+ .0045	+ .09
5679	+ .0090	0.9	− .931	+332	+ .0033	+ .07
5680	+0.0128	1.0	−0.931	+332	−0.0005	−0.01

The normal equations are:

$$21.0c + 0.353\mu - 3.9394\pi = + 0.2660 \text{ mm.}$$
$$+ 141.2080\mu + 3.9926\pi = + 0.0012 \text{ mm.}$$
$$+ 14.5927\pi = - 0.0456 \text{ mm.}$$

from which:

$c = + 0.01273$ mm.

$\mu = - 0.00003$ mm. $= - 0''.0007$, or $- 0''.003$ per year.

$\pi = + 0.00032$ mm. $= + \mathbf{0''.007} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00161 \text{ mm.} = \pm 0''.033.$$

ζ SAGITTARII ($18^h\ 56^m$; $-30°\ 1'$)

This well-known and difficult double has components of magnitudes 3.4 and 3.6, respectively, and the center of gravity has a small proper motion 0″.022 per year. On account of its great southern declination, the star is difficult of access to northern observatories. Mr. Olivier measured the McCormick plates with the exception of the four last plates which were measured by Mr. Mitchell. A relative parallax of + 0″.018 ± 0″.008 was determined with a proper motion in right ascension, + 0″.066 while the corresponding value from Boss is − 0″.022. The only determination of the parallax published is the meridian circle result of Flint, + 0″.115 ± 0″.037. Aitken (*Publications of the Lick Observatory*, **12**, 135, 1914), finds the period of revo-

TABLE 1

PLATES OF ζ SAGITTARII

No.	Date.	Hour Angle.	Observers.	Weight.
3045	1916 Sept. 20	0h0	M	0.9
3054	Sept. 21	+0.4	M	0.8
3089	Sept. 26	0.0	Ol	0.8
3910	1917 Apr. 22	−0.6	L	1.0
3911	Apr. 22	−0.3	L	0.7
4013	May 25	−1.0	Ol	0.7
4418	Sept. 12	−0.5	Ol	0.9
4419	Sept. 12	−0.1	Ol	0.6*
4430	Sept. 13	−0.3	M	1.0
4431	Sept. 13	0.0	A	1.0
4432	Sept. 17	−0.2	M	0.6*
5327	1918 Apr. 27	−0.7	Ol	0.8
5328	Apr. 27	−0.2	Ol	1.2†
5372	May 16	−1.2	Ol	1.0
5373	May 16	−0.7	Ol	1.0
5681	Sept. 14	+0.4	M	0.8
5682	Sept. 14	+0.8	M	1.0
5707	Sept. 22	+0.8	M	1.0
5708	Sept. 22	+1.2	M	1.0

* One exposure. † Three exposures.

lution of the double to be 21.17 years, and the semi-major axis, $a = 0''.565$. With these values and the McCormick parallax, the mass of the system is 33.1 times that of the sun.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−50.5	+17.3	+0.2918
2	.10	−41.7	−40.8	.1192
3	.11	+ 7.6	+ 1.9	.1949
4	.19	+34.6	−16.0	.1290
5	.17	+50.0	+37.6	+0.2151
Parallax star	0.19	− 5.1	+ 4.5	

TABLE 2

REDUCTIONS FOR ζ SAGITTARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3045	−0.0140	0.9	−0.962	−408	−0.0006	−0″.01
3054	− .0119	0.8	− .967	−407	− .0027	− .05
3089	− .0154	0.8	− .983	−402	+ .0008	+ .01
3910	− .0122	1.0	+ .944	−194	+ .0011	+ .02
3911	− .0096	0.7	+ .944	−194	− .0015	− .03
4013	− .0112	0.7	+ .630	−161	+ .0001	.00
4418	− .0148	0.9	− .918	− 51	+ .0033	+ .07
4419	− .0119	0.6	− .918	− 51	+ .0004	+ .01
4430	− .0106	1.0	− .924	− 50	− .0009	− .02
4431	− .0111	1.0	− .924	− 50	− .0004	− .01
4432	− .0148	0.6	− .947	− 46	+ .0033	+ .05
5327	− .0054	0.8	+ .915	+176	− .0025	− .05
5328	− .0070	1.2	+ .915	+176	− .0009	− .02
5372	− .0081	1.0	+ .743	+195	+ .0002	.00
5373	− .0110	1.0	+ .743	+195	+ .0031	+ .06
5681	− .0124	0.8	− .929	+316	+ .0041	+ .08
5682	− .0086	1.0	− .929	+316	+ .0003	+ .01
5707	− .0048	1.0	− .969	+324	− .0034	− .07
5708	−0.0060	1.0	−0.969	+324	−0.0022	−0.05

The normal equations are:

$$16.8c + 2.978\mu - 4.4674\pi = -0.1734 \text{ mm.}$$
$$+ 103.1612\mu + 2.4619\pi = +0.0612 \text{ mm.}$$
$$+ 13.8664\pi = +0.0597 \text{ mm.}$$

from which:

$c = -0.01025$ mm.

$\mu = +0.00087$ mm. $= +0''.0181$, or $+0''.066$ per year.

$\pi = +0.00085$ mm. $= +\mathbf{0''.018 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00144 \text{ mm.} = \pm 0''.030.$$

ζ AQUILÆ ($19^h\ 1^m$; $+13°\ 43'$)

This is a star of 3.02 magnitude and A type, with total proper motion of $0''.10$. The only value of the parallax published is that of the Allegheny Observatory as the result of photography: $+0''.036 \pm 0''.008$. The McCormick plates were measured by Mr. Olivier who found the proper motion in right ascension to be $-0''.023$ while the value from Boss is $-0''.009$.

TABLE 1

PLATES OF ζ AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
1526	1915 Aug. 6	$+0^h.7$	Ol	0.8
1553	Aug. 14	+0.6	Ol	0.7*
1579	Aug. 25	0.0	Ol	0.9
1580	Aug. 25	+0.7	Ol	1.0
1731	Sept. 22	0.0	M	0.6*
2667	1916 May 17	−0.3	G	0.8
2668	May 17	0.0	G	1.0
2669	May 17	+0.5	G	0.9
2704	June 3	−1.0	M	1.0
2705	June 3	−0.6	M	1.0
2850	Aug. 7	+0.3	Ol	0.8
2851	Aug. 7	+0.7	Ol	0.5*
2914	Aug. 21	−0.5	Ol	0.8
2915	Aug. 21	0.0	Ol	1.0
2916	Aug. 21	+0.2	Ol	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−69.9	−32.0	+0.1902
2	.17	−33.7	+39.1	.2312
3	.20	+16.9	+ 1.7	.1984
4	.16	+42.7	+19.5	.2060
5	.24	+44.0	−28.3	+0.1742
Parallax star	0.19	− 1.3	+ 2.4	

TABLE 2

REDUCTIONS FOR ζ AQUILÆ

Plate.	Solution (*m*).	Weight (*p*).	Parallax Factor (*P*).	Time in Days (*t*).	Residual (*v*).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1526	+0.0048	0.8	−0.495	−228	+0.0013	+0″.02
1553	+ .0079	0.7	− .606	−220	− .0020	− .03
1579	+ .0046	0.9	− .741	−207	+ .0011	+ .02
1580	+ .0056	1.0	− .741	−207	+ .0001	.00
1731	+ .0068	0.6	− .953	−183	− .0014	− .02
2667	+ .0080	0.8	+ .738	+ 57	− .0013	− .02
2668	+ .0068	1.0	+ .738	+ 57	− .0001	.00
2669	+ .0045	0.9	+ .738	+ 57	+ .0022	+ .04
2704	+ .0050	1.0	+ .519	+ 74	+ .0014	+ .03
2705	+ .0090	1.0	+ .519	+ 74	− .0026	− .05
2850	+ .0064	0.8	− .520	+139	− .0015	− .03
2851	+ .0048	0.5	− .520	+139	+ .0001	.00
2914	+ .0038	0.8	− .704	+153	+ .0008	+ .01
2915	+ .0054	1.0	− .704	+153	− .0008	− .02
2916	+0.0023	0.7	−0.704	+153	+0.0023	+0.04

The normal equations are:

$$12.5c + 0.256\mu - 2.2053\pi = + 0.0720 \text{ mm.}$$
$$+ 28.0338\mu + 4.0683\pi = - 0.0025 \text{ mm.}$$
$$+ 5.6411\pi = - 0.0073 \text{ mm.}$$

from which:

$c = +0.00599$ mm.

$\mu = -0.00033$ mm. $= -0''.0062$, or $-0''.023$ per year.

$\pi = +0.00128$ mm. $= +\mathbf{0''.027 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00102 \text{ mm.} = \pm 0''.021.$$

π SAGITTARII ($19^h\ 3^m$; $-21°\ 10'$)

The spectroscopic parallax $+0''.008$ has been found for this star which is of 3.02 magnitude, of F type, and of small proper motion, $0''.04$. Mr. Olivier measured the McCormick plates and found a proper motion in right ascension of $+0''.032$ while the value from Boss is $-0''.005$.

TABLE 1

PLATES OF π SAGITTARII

No.	Date.	Hour Angle.	Observers.	Weight.
1683	1915 Sept. 14	$+0^h.1$	M	0.9
1684	Sept. 14	+0.5	M	1.0
1693	Sept. 15	−0.1	Ol	0.9
2888	1916 Aug. 18	−0.6	Ol	1.0
2889	Aug. 18	−0.1	Ol	0.9
2890	Aug. 18	+0.3	Ol	0.7
2898	Aug. 19	0.0	Ol	0.9
2899	Aug. 19	+0.3	Ol	0.7
3975	1917 May 18	−0.8	Ol	1.0
3976	May 18	−0.4	Ol	0.8
4014	May 25	−0.5	Ol	0.9
4015	May 25	0.0	Ol	1.0
4021	May 29	1.1	Ol	1.0
4022	May 29	−0.6	Ol	1.0
4263	Aug. 13	−0.4	Ol	0.9
4264	Aug. 13	+0.1	Ol	1.0
4323	Aug. 24	+0.3	Ol	0.7
4324	Aug. 24	−0.1	Ol	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−56.2	−40.6	+0.2142
2	.13	−58.6	+14.1	.1346
3	.12	+22.8	+17.8	.1923
4	.15	+50.8	+34.1	.1909
5	.09	+41.2	−25.4	+0.2680
Parallax star	0.16	+ 5.2	− 3.7	

TABLE 2

REDUCTIONS FOR π SAGITTARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1683	+0.0099	0.9	−0.914	−457	−0.0011	−0″.02
1684	+ .0110	1.0	− .914	−457	− .0022	− .05
1693	+ .0059	0.9	− .920	−456	+ .0029	+ .06
2888	+ .0081	1.0	− .657	−118	− .0006	− .01
2889	+ .0032	0.9	− .657	−118	+ .0043	+ .09
2890	+ .0098	0.7	− .657	−118	− .0023	− .04
2898	+ .0092	0.9	− .670	−117	− .0017	− .03
2899	+ .0061	0.7	− .670	−117	+ .0014	+ .02
3975	+ .0066	1.0	+ .730	+155	+ .0006	+ .01
3976	+ .0098	0.8	+ .730	+155	− .0026	− .05
4014	+ .0052	0.9	+ .823	+162	+ .0020	+ .04
4015	+ .0095	1.0	+ .823	+162	− .0023	− .05
4021	+ .0056	1.0	+ .602	+166	+ .0015	+ .03
4022	+ .0066	1.0	+ .602	+166	+ .0005	+ .01
4263	+ .0072	0.9	− .588	+242	− .0011	− .02
4264	+ .0044	1.0	− .588	+242	+ .0017	+ .04
4323	+ .0058	0.7	− .726	+253	+ .0002	.00
4324	+0.0073	1.0	−0.726	+253	−0.0014	−0.03

The normal equations are:

$$16.3c + 0.360\mu - 3.6145\pi = + 0.1187 \text{ mm.}$$
$$+ 101.0368\mu + 15.7242\pi = - 0.0303 \text{ mm.}$$
$$+ 8.7134\pi = - 0.0283 \text{ mm.}$$

from which:

$c = +0.00742$ mm.

$\mu = -0.00042$ mm. $= -0''.0087$, or $-0''.032$ per year.

$\pi = +0.00058$ mm. $= +\mathbf{0''.012} \pm \mathbf{0''.012}$.

Probable error of plate of unit weight

± 0.00136 mm. $= \pm 0''.028$.

AQUILÆ 59 ($19^h\ 8^m$; $+16°\ 41'$)

The principal star of this wide pair, separated 120″, is of magnitude 6.44 and type A, and the companion of magnitude 7.5. By means of the six-inch telescope, Burnham found the brighter star to be a double, but with little change. The brighter star is Lalande 36081, and has a small proper motion of 0″.03, while the fainter is Lalande 36074 with a total proper motion of 0″.22, and according to Porter, a proper motion in right ascension of + 0″.138. Mr. Mitchell measured the McCormick

TABLE 1

PLATES OF AQUILÆ 59

No.	Date.	Hour Angle.	Observers.	Weight.
294	1914 Sept. 22	+1h0	M	0.4*
299	Sept. 23	+0.7	M, G	0.8
1269	1915 May 1	−1.0	M	1.0
1302	May 10	−0.7	G	0.9
1339	June 5	−1.1	M	0.8
1342	June 6	−0.6	A	0.8
1524	Aug. 6	−0.7	Ol	0.8
1568	Aug. 23	−0.4	Ol	0.7*
1569	Aug. 23	0.0	Ol	0.9
1600	Sept. 6	−0.6	Ol	0.8
1601	Sept. 6	−0.2	M	0.8
1822	Oct. 12	+0.6	M	0.8
1823	Oct. 12	+0.9	M	1.0
2652	1916 May 7	0.0	A	0.8
2661	May 14	−0.7	A	1.0
2662	May 14	−0.1	A	1.0

* One exposure.

series of photographs. No other parallax measures have been published.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependences.	
				Brighter.	Fainter.
	mm.	mm.	mm.		
1	0.15	−16.4	− 9.6	+0.224	+0.369
2	.16	−10.8	+43.1	.410	.383
3	.17	+27.2	−33.5	+0.366	+0.248
Brighter star	.18	+ 1.9	+ 3.2		
Fainter star	0.14	− 3.4	+ 4.6		

TABLE 2

REDUCTIONS FOR AQUILÆ 59, BRIGHTER STAR

Plate.	Solution (*m*).	Weight (*p*).	Parallax Factor (*P*).	Time in Days (*t*).	Residual (*v*).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
294	+0.0063	0.4	−0.951	−302	+0.0020	+0″.03
299	+ .0105	0.8	− .958	−301	− .0021	− .04
1269	+ .0094	1.0	+ .907	− 81	− .0009	− .02
1302	+ .0083	0.9	+ .835	− 72	+ .0002	.00
1339	+ .0088	0.8	+ .525	− 46	− .0002	.00
1342	+ .0065	0.8	+ .511	− 45	+ .0021	+ .04
1524	+ .0098	0.8	− .467	+ 16	− .0009	− .02
1568	+ .0082	0.7	− .697	+ 33	+ .0008	+ .01
1569	+ .0062	0.9	− .697	+ 33	+ .0028	+ .05
1600	+ .0071	0.8	− .843	+ 47	+ .0019	+ .04
1601	+ .0113	0.8	− .843	+ 47	− .0022	− .04
1822	+ .0096	0.8	− .990	+ 83	− .0004	− .01
1823	+ .0100	1.0	− .990	+ 83	− .0008	− .02
2652	+ .0079	0.8	+ .854	+291	+ .0014	+ .02
2661	+ .0086	1.0	+ .788	+298	+ .0007	+ .01
2662	+0.0118	1.0	+0.788	+298	−0.0025	−0.05

The normal equations are:

$$13.3c + 5.388\mu - 1.0199\pi = + 0.1183 \text{ mm.}$$
$$+ 38.6736\mu + 5.9466\pi = + 0.0543 \text{ mm.}$$
$$+ 8.6538\pi = - 0.0093 \text{ mm.}$$

from which:

$c = +0.00880$ mm.

$\mu = +0.00021$ mm. $= +0''.0043$, or $+0''.016$ per year.

$\pi = -0.00018$ mm. $= -\mathbf{0''.004 \pm 0''.008}$.

Probable error of plate of unit weight

± 0.00109 mm. $= \pm 0''.022$.

TABLE 3

REDUCTIONS FOR AQUILÆ 59, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
294	+0.0073	0.4	−0.951	−302	+0.0010	+0″.01
299	+ .0087	0.8	− .958	−301	− .0004	− .01
1269	+ .0110	1.0	+ .907	− 81	+ .0003	+ .01
1302	+ .0118	0.9	+ .835	− 72	− .0005	− .01
1339	+ .0140	0.8	+ .525	− 46	− .0028	− .05
1342	+ .0090	0.8	+ .511	− 45	+ .0022	+ .04
1524	+ .0125	0.8	− .467	+ 16	− .0016	− .03
1568	+ .0101	0.7	− .697	+ 33	+ .0007	+ .01
1569	+ .0088	0.9	− .697	+ 33	+ .0020	+ .04
1600	+ .0064	0.8	− .843	+ 47	+ .0044	+ .04
1601	+ .0110	0.8	− .843	+ 47	− .0002	.00
1822	+ .0145	0.8	− .990	+ 83	− .0035	− .06
1823	+ .0124	1.0	− .990	+ 83	− .0014	− .03
2652	+ .0172	0.8	+ .854	+291	− .0033	− .06
2661	+ .0134	1.0	+ .788	+298	+ .0004	+ .01
2662	+0.0113	1.0	+0.788	+298	+0.0025	+0.05

The normal equations are:

$$13.3c + 5.388\mu - 1.0199\pi = +0.1513 \text{ mm.}$$
$$+ 38.6736\mu + 5.9466\pi = +0.0919 \text{ mm.}$$
$$+ 8.6538\pi = -0.0004 \text{ mm.}$$

from which:

$c = +0.01115$ mm.

$\mu = +0.00070$ mm. $= +0''.0147$, or $+0''.054$ per year.

$\pi = +0.00078$ mm. $= +\mathbf{0''.016 \pm 0''.011}$.

Probable error of plate of unit weight

± 0.00146 mm. $= \pm 0''.030$.

Σ 2481 ($19^h\ 8^m$; +38° 37′)

This is a triple system. A and B form the double Σ 2481, of magnitudes 8.0 and 8.0, and separated by 3″.8. B and C are separated by 0″.4, and were discovered by Secchi in 1856. According to Burnham, the proper motion of the triple system is 0″.273. The movement of BC with respect to A is rectilinear, "from which it may be inferred that the double component has a proper motion differing slightly in direction and amount from that of A." The parallaxes of these stars have been determined at Swarthmore by photography with the results: for the star A, $\pi = +\ 0''.016 \pm 0''.009$, while for the pair BC, $\pi = -\ 0''.011 \pm 0''.009$. Adams and Joy have found the spectroscopic parallax + 0″.036 and + 0″.050, respectively. Mr. Mitchell measured the McCormick photographs. Since these stars form a physical system, they must have a common parallax. The combined value gives the McCormick result for the relative parallax:

+ 0″.032 ± 0″.007.

TABLE 1

PLATES OF Σ 2481

No.	Date.	Hour Angle.	Observers.	Weight.
171	1914 Aug. 7	−0^{h}4	Ol	0.8
1310	1915 May 13	−1.3	M	0.9
1326	May 22	−1.0	M	1.0
1362	June 10	−1.5	M	1.0
1363	June 10	−1.1	M	0.8
1612	Sept. 7	−0.4	A	1.0
1630	Sept. 9	−0.2	Ol	0.9
1639	Sept. 10	−0.8	M	0.8
1640	Sept. 10	−0.4	Ol, A	1.0
1663	Sept. 12	−0.7	M	0.9
1664	Sept. 12	−0.3	M	0.8
2683	1916 May 30	−0.9	M	0.8
2684	May 30	−0.6	M	0.8
2692	June 1	−1.3	M	0.7
2693	June 1	−1.1	M	0.9

An orbit by Russell (*Lick Observatory Publications*, **12**, 138, 1914), gives the period of BC = Secchi 2 to be 58 years, and $a = 0''.40$. With these values, and the McCormick value of the parallax, the mass of the system BC is 0.38 times that of the sun.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−24.8	−34.4	+0.277
2	.16	−12.8	+25.0	.409
3	.14	+37.6	+ 9.4	+0.314
Principal star	.19	− 0.4	+ 3.6	
Companion	0.18	− 0.2	+ 3.7	

TABLE 2

REDUCTIONS FOR Σ 2481, PRINCIPAL STAR, A

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
171	+0.0324	0.8	−0.487	−448	+0.0001	0″.00
1310	+ .0254	0.9	+ .805	−169	+ .0027	+ .05
1326	+ .0307	1.0	+ .707	−160	− .0030	− .06
1362	+ .0261	1.0	+ .451	−141	+ .0005	+ .01
1363	+ .0266	0.8	+ .451	−141	.0000	.00
1612	+ .0225	1.0	− .853	− 52	− .0011	− .02
1630	+ .0199	0.9	− .870	− 50	+ .0014	+ .03
1639	+ .0239	0.8	− .878	− 49	− .0026	− .05
1640	+ .0208	1.0	− .878	− 49	+ .0005	+ .01
1663	+ .0178	0.9	− .873	− 47	+ .0034	+ .06
1664	+ .0232	0.8	− .873	− 47	− .0020	− .04
2683	+ .0180	0.8	+ .596	+214	− .0003	.00
2684	+ .0204	0.8	+ .596	+214	− .0027	− .05
2692	+ .0153	0.7	+ .569	+216	+ .0023	+ .04
2693	+0.0168	0.9	+0.569	+216	+0.0008	+0.02

The normal equations are:

$$13.1c - 5.014\mu - 0.9828\pi = + 0.2983 \text{ mm.}$$
$$+ 40.8608\mu + 4.5593\pi = - 0.2056 \text{ mm.}$$
$$+ 6.8173\pi = - 0.0182 \text{ mm.}$$

from which:

$c = +0.02195$ mm.

$\mu = -0.00259$ mm. $= -0''.0538$, or $-0''.196$ per year.

$\pi = +0.00223$ mm. $= +\mathbf{0''.046 \pm 0''.011}$.

Probable error of plate of unit weight

± 0.00136 mm. $= \pm 0''.028$.

TABLE 3

REDUCTIONS FOR Σ 2481, BC (SECCHI 2)

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
171	+0.1628	0.8	−0.487	−448	+0.0010	+0″.02
1310	+ .1550	0.9	+ .805	−169	− .0012	− .02
1326	+ .1546	1.0	+ .707	−160	− .0013	− .03
1362	+ .1516	1.0	+ .451	−141	+ .0007	+ .01
1363	+ .1508	0.8	+ .451	−141	+ .0015	+ .03
1612	+ .1498	1.0	− .853	− 52	− .0022	− .04
1630	+ .1474	0.9	− .870	− 50	+ .0001	.00
1639	+ .1513	0.8	− .878	− 49	− .0038	− .07
1640	+ .1474	1.0	− .878	− 49	+ .0001	.00
1663	+ .1444	0.9	− .873	− 47	+ .0030	+ .06
1664	+ .1458	0.8	− .873	− 47	+ .0016	+ .03
2683	+ .1380	0.8	+ .596	+214	+ .0002	.00
2684	+ .1365	0.8	+ .596	+214	+ .0017	+ .03
2692	+ .1380	0.7	+ .569	+216	+ .0001	.00
2693	+0.1392	0.9	+0.569	+216	−0.0010	−0.02

The normal equations are:

$$13.1c - 5.014\mu - 0.9828\pi = +1.9356 \text{ mm.}$$
$$+40.8608\mu + 4.5593\pi = -0.8929 \text{ mm.}$$
$$+6.8173\pi = -0.1561 \text{ mm.}$$

from which:

$c = +0.14629$ mm.

$\mu = -0.00400$ mm. $= -0''.0832$, or $-0''.304$ per year.

$\pi = +0.00087$ mm. $= +\mathbf{0''.018 \pm 0''.010}$.

Probable error of plate of unit weight

± 0.00117 mm. $= \pm 0''.024$.

Σ 2486 ($19^h\ 9^m$; +49° 37′)

This star, which is also called Cygni 6, is an interesting example of the wide discordances of the early values of the parallax. The McCormick results given below for these stars have already been published in the *Astrophysical Journal*, **42**, 263, 1915. Before their publication, the following values of their parallax had been obtained:

Authority.	Method.	Brighter Star A.	Fainter Star B.	Center of Gravity $\frac{AB}{2}$.
Ball	Equatorial (distance)	+0″.504±0″.060		
Ball	Equatorial (pos. ang.)	+0.383±0.13		
Ball	Equatorial (dist. and pos. ang.)	+0.482±0.054		
A. Hall	Equatorial ($\Delta\delta$)	−0.094±0.025		
A. Hall	Equatorial ($\Delta\delta$)	−0.137±0.017		
A. Hall	Equatorial ($\Delta\alpha$)	+0.023±0.009		
Chase	Heliometer		−0.027±0.039	
Kostinsky	Photography	+0.04 ±0.03	+0.05 ±0.03	+0.04 ±0.02
Russell	Photography	−0.011±0.049	+0.075±0.063	
Flint	Meridian Circle			+0.045±0.021
Jewdokimov	Meridian Circle			+0.094±0.055

These stars form a system of the 61 Cygni class, with nearly common proper motion of 0″.64 per year in position angle 344°. The stars are of type K, and of magnitudes 6.6 and 6.8. According to Adams and Kohlschütter (*Astrophysical Journal*, **39**, 346, 1914), these stars, though separated by nearly 10″, undoubtedly form a physical system since they have radial velocities of − 41 and − 39 km. respectively. The values of the parallaxes below, and their common proper motion confirm this idea. The

rotating sector was used. The plates were measured by Mr. Mitchell.

TABLE 1

PLATES OF Σ 2486

No.	Date.	Hour Angle.	Observers.	Weight.
52	1914 May 30	−0h8	M	0.9
53	May 30	−0.3	M	1.0
58	May 31	−1.1	M	0.7
59	May 31	−0.7	M	1.0
212	Sept. 7	−0.2	M	1.0
237	Sept. 14	−0.1	M, A	1.0
278	Sept. 21	−0.5	M	1.0
279	Sept. 21	0.0	M	1.0
291	Sept. 22	−0.4	M	0.9
292	Sept. 22	0.0	M	1.0
346	Sept. 29	−0.1	M	1.0
1184	1915 Apr. 12	−1.3	M	0.7
1185	Apr. 12	−1.0	M	1.0
1196	Apr. 13	−1.1	Ol	1.0
1204	Apr. 14	−1.2	A	1.0
1205	Apr. 14	−0.9	A	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−55.3	−27.8	+0.192
2	.20	−25.1	+41.2	+ .185
3	.10	+ 9.6	−32.7	+ .209
4	.10	+10.0	+32.6	+ .196
5	.21	+60.8	−13.3	+0.218.
Brighter	.18	+ 1.9	− 1.2	
Fainter	0.16	+ 2.1	− 0.9	

The mean for the two stars gives the parallax of the system,

$$+ 0''.043 \pm 0''.005.$$

With the 60-inch reflector at Mt. Wilson, Van Maanen derives the parallax of the brighter star to be $+ 0''.042 \pm 0''.004$, and

TABLE 2

REDUCTION FOR Σ 2486 (SEQ). BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in. Arc.
	mm.				mm.	
52	−0.0032	0.9	+0.608	−137	+0.0007	+0″.01
53	− .0020	1.0	+ .608	−137	− .0005	− .01
58	− .0008	0.7	+ .595	−136	− .0017	− .03
59	− .0035	1.0	+ .595	−136	+ .0010	+ .02
212	− .0094	1.0	− .852	− 37	+ .0004	+ .01
237	− .0082	1.0	− .906	− 30	− .0012	− .02
278	− .0094	1.0	− .948	− 23	− .0003	− .01
279	− .0103	1.0	− .948	− 23	+ .0006	+ .01
291	− .0103	0.9	− .952	− 22	+ .0006	+ .01
292	− .0116	1.0	− .952	− 22	+ .0019	+ .04
346	− .0081	1.0	− .978	− 15	− .0019	− .04
1184	− .0080	0.7	+ .990	+180	− .0030	− .05
1185	− .0112	1.0	+ .990	+180	+ .0002	.00
1196	− .0116	1.0	+ .988	+181	+ .0006	+ .01
1204	− .0115	1.0	+ .986	+182	+ .0004	+ .01
1205	−0.0120	1.0	+0.986	+182	+0.0009	+0.02

The normal equations are:

$$15.2c + 1.897\mu + 0.3689\pi = - 0.1271 \text{ mm.}$$
$$+ 22.5665\mu + 7.0162\pi = - 0.0655 \text{ mm.}$$
$$+ 11.9135\pi = + 0.0053 \text{ mm.}$$

from which:

$c = - 0.00805$ mm.

$\mu = - 0.00299$ mm. $= - 0''.0622$, or $- 0''.227$ per year.

$\pi = + 0.00245$ mm. $= + \mathbf{0''.051 \pm 0''.006}$.

Probable error corresponding to unit weight

$$\pm 0.00086 \text{ mm.} = \pm 0''.018.$$

for the fainter star + 0″.044 ± 0″.003, with a mean of + 0″.043 ± 0″.003. The spectroscopic parallax for A and B is + 0″.076 and ± 0″.069, respectively.

TABLE 3

REDUCTION FOR Σ 2486 (PR). FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
52	+0.0541	0.9	+0.608	−137	+0.0018	+0″.04
53	+ .0543	1.0	+ .608	−137	+ .0016	+ .03
58	+ .0588	0.7	+ .595	−136	− .0021	− .05
59	+ .0570	1.0	+ .595	−136	− .0012	− .02
212	+ .0508	1.0	− .852	− 37	− .0012	− .02
237	+ .0475	1.0	− .906	− 30	+ .0018	+ .04
278	+ .0499	1.0	− .948	− 23	− .0009	− .02
279	+ .0481	1.0	− .948	− 23	+ .0009	+ .02
291	+ .0482	0.9	− .952	− 22	+ .0007	+ .01
292	+ .0474	1.0	− .952	− 22	+ .0015	+ .03
346	+ .0513	1.0	+ .978	− 15	− .0027	− .06
1184	+ .0468	0.7	+ .990	+180	− .0020	− .04
1185	+ .0452	1.0	+ .990	+180	− .0004	− .01
1196	+ .0446	1.0	+ .988	+181	+ .0002	.00
1204	+ .0432	1.0	+ .986	+182	+ .0015	+ .03
1205	+0.0446	1.0	+0.986	+182	+0.0001	0.00

The normal equations are:

$$15.2c + 1.897\mu + 0.3689\pi = + 0.7499 \text{ mm.}$$
$$+ 22.5665\mu + 7.0162\pi = + 0.0230 \text{ mm.}$$
$$+ 11.9135\pi = + 0.0130 \text{ mm.}$$

from which:

$c = + 0.04975$ mm.

$\mu = - 0.00370$ mm. $= - 0''.0770$, or $- 0''.281$ per year.

$\pi = + 0.00173$ mm. $= + \mathbf{0''.036 \pm 0''.007}$.

Probable error corresponding to unit weight

$$\pm 0.00107 \text{ mm.} = \pm 0''.022.$$

ρ SAGITTARII ($19^h\ 15^m$; $-18°\ 2'$)

The spectroscopic parallax of $+\ 0''.033$ has been found for this star of magnitude 3.95, of type F, and of total proper motion $0''.031$. Thirteen of the McCormick plates were measured by Mr. Briggs, and eight by Mr. Mitchell. The relative parallax determined was $+\ 0''.044 \pm 0''.010$, with a proper motion in right ascension $-\ 0''.007$ while the corresponding value from Boss is $-\ 0''.024$.

TABLE 1

PLATES OF ρ SAGITTARII

No.	Date.	Hour Angle.	Observers.	Weight.
1705	1915 Sept. 16	0^h0	A	1.0
1706	Sept. 16	+0.3	A	1.0
1742	Sept. 23	−0.2	M	1.0
1754	Sept. 24	−0.5	A	1.0
2926	1916 Aug. 26	+0.3	Ol	1.0
2927	Aug. 26	+0.4	Ol	0.6*
2963	Sept. 4	+0.4	Ol	1.0
2964	Sept. 4	0.0	Ol	0.7
4049	1917 June 8	−0.1	A	1.0
4062	June 13	−0.5	Ol	0.8
4063	June 13	−0.2	Ol	0.8
4236	Aug. 4	+0.4	B	1.0
4407	Sept. 11	+0.1	M	1.0
4408	Sept. 11	+0.4	B	1.0
4480	Sept. 29	+0.5	B, M	1.0
5444	1918 June 9	−0.7	A	1.0
5445	June 9	−0.3	A	1.0
5478	June 23	+0.4	Ol	1.0
5479	June 23	+0.9	Ol	1.0
5774	Oct. 9	+0.3	M, F	0.9
5775	Oct. 9	+0.6	F, D	0.8

* One observation.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−38.6	− 1.6	+0.3011
2	.12	−38.1	−22.8	.1314
3	.12	+ 5.4	+20.9	.4077
4	.20	+71.3	+ 3.5	+0.1598
Parallax star	0.17	− 3.0	+ 5.6	

TABLE 2

REDUCTIONS FOR ρ SAGITARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1705	−0.0106	1.0	−0.905	−593	+0.0009	+0″.02
1706	− .0089	1.0	− .905	−593	− .0008	− .02
1742	− .0073	1.0	− .946	−586	− .0025	− .05
1754	− .0101	1.0	− .951	−585	+ .0003	+ .01
2926	− .0138	1.0	− .717	−248	+ .0042	+ .09
2927	− .0076	0.6	− .717	−248	− .0020	− .03
2963	− .0092	1.0	− .812	−239	− .0006	− .01
2964	− .0103	0.7	− .812	−239	+ .0005	+ .01
4049	− .0102	1.0	+ .502	+ 38	+ .0029	+ .06
4062	− .0081	0.8	+ .428	+ 43	+ .0006	+ .01
4063	− .0072	0.8	+ .428	+ 43	− .0003	.00
4236	− .0090	1.0	− .415	+ 95	− .0003	− .01
4407	− .0105	1.0	− .872	+133	+ .0002	.00
4408	− .0090	1.0	− .872	+133	− .0013	− .03
4480	− .0091	1.0	− .973	+151	− .0014	− .03
5444	− .0056	1.0	+ .491	+404	− .0021	− .04
5445	− .0073	1.0	+ .491	+404	− .0004	− .01
5478	− .0070	1.0	+ .275	+418	− .0012	− .02
5479	− .0082	1.0	+ .275	+418	.0000	.00
5774	− .0122	0.9	− .989	+526	+ .0013	+ .02
5775	−0.0125	0.8	−0.989	+526	+0.0016	+0.03

The normal equations are:

$$19.6c - 0.031\mu - 8.3291\pi = -0.1808 \text{ mm.}$$
$$+ 280.2267\mu + 21.7093\pi = +0.0189 \text{ mm.}$$
$$+ 10.8618\pi = +0.0901 \text{ mm.}$$

from which:

$c = -0.00833$ mm.

$\mu = -0.00010$ mm. $= -0''.0020$, or $-0''.007$ per year.

$\pi = +0.00210$ mm. $= +\mathbf{0''.044 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00113 \text{ mm.} = \pm 0''.024.$$

δ AQUILAE ($19^h\ 20^m$; $+2°\ 54'$)

By photography, the Allegheny Observatory has found the parallax of this star to be $+0''.062 \pm 0''.007$. The spectroscopic value is $+0''.044$. It is of magnitude 3.44, of type F, and of total proper motion $0''.264$. Mr. Olivier measured the McCormick plates and found the relative parallax $+0''.041 \pm 0''.010$, with a proper motion in right ascension $+0''.270$ while the corresponding value from Boss is $+0''.253$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−43.4	+ 7.1	+0.2543
2	.16	−14.8	−27.3	.2297
3	.10	− 3.6	+19.8	.2645
4	.10	+61.8	+ 0.4	+0.2515
Parallax star	0.14	+ 0.2	+ 0.9	

TABLE 1

PLATES OF δ AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
238	1914 Sept. 14	+0h2	M, A	0.7
239	Sept. 14	+0.6	M, A	0.7
327	Sept. 27	+0.5	M	0.7
328	Sept. 27	+0.9	M	0.8
372	Oct. 5	+0.7	Ol, M	0.8
375	Oct. 6	+0.5	M	0.7
1214	1915 Apr. 15	−1.7	M	0.7
1215	Apr. 15	−1.3	M	0.9
1224	Apr. 17	−1.2	M	0.7
1336	June 4	+0.2	Ol	0.7
1337	June 4	+1.0	Ol	0.7
1372	June 18	−0.7	M	0.6
1828	Oct. 21	+1.0	M	0.9
1837	Oct. 24	+0.9	M	0.9
1852	Oct. 25	+0.8	M	0.8
2620	1916 Apr. 29	−0.7	Ol	1.0†
2632	May 1	−0.8	Ol	0.9
2633	May 1	−0.4	Ol	0.6*
2687	May 31	−1.3	Ol	0.7
4265	1917 Aug. 13	+0.6	Ol	0.5*
4266	Aug. 13	+1.2	Ol	0.5*
4312	Aug. 21	+0.4	B	1.0
4313	Aug. 21	+0.8	B	1.0
4326	Aug. 24	+0.8	Ol	1.1†
4327	Aug. 24	+1.2	Ol	1.0
5319	1918 Apr. 23	−0.8	Ol	0.7
5361	May 9	−0.8	Ol	0.6*
5370	May 14	0.0	Ol	1.0
5426	June 7	−0.7	Ol	0.7
5427	June 7	−0.2	Ol	0.6*
5456	June 15	0.0	A	0.9
5457	June 15	+0.4	A	0.9
5767	Oct. 8	+0.2	M	0.9
5781	Oct. 10	+0.1	F	0.9
5782	Oct. 10	+0.5	H	0.9

* One exposure. † Three exposures.

TABLE 2

REDUCTIONS FOR δ AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
238	−0.0142	0.7	−0.884	−728	−0.0015	−0″.03
239	− .0134	0.7	− .884	−728	− .0023	− .04
327	− .0160	0.7	− .960	−715	+ .0006	+ .01
328	− .0180	0.8	− .960	−715	+ .0026	+ .05
372	− .0115	0.8	− .983	−707	− .0037	− .07
375	− .0072	0.7	− .984	−706	− .0080	− .14
1214	− .0004	0.7	+ .988	−515	− .0040	− .07
1215	− .0087	0.9	+ .988	−515	+ .0043	+ .08
1224	− .0106	0.7	+ .984	−513	+ .0062	+ .11
1336	− .0068	0.7	+ .579	−465	+ .0033	+ .06
1337	− .0042	0.7	+ .579	−465	+ .0007	+ .01
1372	− .0041	0.6	+ .375	−451	+ .0007	+ .01
1828	− .0061	0.9	− .974	−326	+ .0045	+ .09
1837	− .0054	0.9	− .964	−323	+ .0039	+ .08
1852	− .0048	0.8	− .960	−322	+ .0034	+ .06
2620	+ .0087	1.0	+ .932	−135	+ .0003	+ .01
2632	+ .0117	0.9	+ .920	−133	− .0027	− .05
2633	+ .0102	0.6	+ .920	−133	− .0012	− .02
2687	+ .0141	0.7	+ .623	−103	− .0046	− .08
4265	+ .0287	0.5	− .532	+336	− .0058	− .09
4266	+ .0208	0.5	− .532	+336	+ .0021	+ .03
4312	+ .0224	1.0	− .640	+344	+ .0005	+ .01
4313	+ .0268	1.0	− .640	+344	− .0039	− .08
4326	+ .0253	1.1	− .678	+347	− .0023	− .05
4327	+ .0241	1.0	− .678	+347	− .0011	− .02
5319	+ .0381	0.7	+ .964	+589	− .0033	− .06
5361	+ .0343	0.6	+ .865	+605	+ .0009	+ .01
5370	+ .0362	1.0	+ .821	+610	− .0009	− .02
5426	+ .0319	0.7	+ .534	+634	+ .0037	+ .06
5427	+ .0353	0.6	+ .534	+634	+ .0003	.00
5456	+ .0393	0.9	+ .416	+642	− .0036	− .07
5457	+ .0329	0.9	+ .416	+642	+ .0028	+ .05
5767	+ .0356	0.9	− .987	+757	+ .0014	+ .03
5781	+ .0350	0.9	− .988	+759	+ .0020	+ .04
5782	+0.0344	0.9	−0.988	+759	+0.0026	+0.05

The normal equations are:

$$27.7c + 6.608\mu - 3.0564\pi = + 0.3485 \text{ mm.}$$
$$+ 786.9724\mu + 7.8374\pi = + 2.8976 \text{ mm.}$$
$$+ 18.7150\pi = + 0.0286 \text{ mm.}$$

from which:

$c = + 0.01195$ mm.
$\mu = + 0.00356$ mm. $= + 0.0741$, or $0''.270$ per year.
$\pi = + 0.00199$ mm. $= + \mathbf{0''.041} \pm \mathbf{0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00200 \text{ mm.} = \pm 0''.042.$$

31 b AQUILAE ($19^h\ 20^m$; $+11°\ 43'$)

This star of magnitude 5.23, of spectral type G7, has a considerable total proper motion $0''.96$. Several discordant values of the parallax have been made, as follows:

Authority.	Method.	Parallax.
Peter	Heliometer	$+0''.06 \pm 0''.015$
Flint	Meridian circle	$+ .01 \pm .030$
Chase	Heliometer	$+ .019 \pm .037$
Schlesinger (Yerkes)	Photography	$+ .101 \pm .022$
Jewdokimov	Meridian circle	$+ .044 \pm .097$
Allegheny	Photography	$+ .055 \pm .011$
Adams and Joy	Spectrograph	$+0''.110$

Ten of the McCormick plates were measured by Mr. Briggs, eight by Mr. Mitchell. The relative parallax $+ 0''.074 \pm 0''.010$ resulted, while the proper motion from the plates in right ascension is $+ 0''.729$ and the corresponding value from Boss $+ 0''.725$. According to Adams and Kohlschütter (*Astrophysical Journal*, **39**, 341, 1914), the radial velocity is $-$ 98 km. per second.

TABLE 1

PLATES OF 31 b AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
2993	1916 Sept. 11	−0h4	Ol	1.0
3090	Sept. 26	−0.3	L	1.0
3139	Oct. 6	+0.6	L	1.0
4043	1917 June 7	0.0	Ol	0.8
4044	June 7	+0.3	Ol	0.7
4079	June 17	−0.5	Ol	0.9
4080	June 17	−0.6	Ol	0.7
4262	Aug. 12	+0.7	B	1.0
4370	Aug. 29	−1.0	A	1.0
4371	Aug. 29	−0.6	A	1.0
4463	Sept. 24	+0.6	B	1.0
5403	1918 May 31	+0.1	A	1.0
5404	May 31	+0.5	A	1.0
5422	June 5	+0.1	L	1.0
5423	June 5	+0.5	L	0.7
5648	Aug. 23	0.0	A	1.0
5649	Aug. 23	+0.4	A	1.0
5819	Oct. 21	+0.7	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−22.1	− 2.9	+0.2105
2	.11	− 9.9	+15.6	.2653
3	.13	− 2.3	+ 4.1	.2545
4	.10	+34.3	−16.8	+0.2697
Parallax star	0.13	+ 1.4	+ 0.0	

TABLE 2

REDUCTIONS FOR 31 b AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2993	−0.0252	1.0	−0.864	−404	−0.0017	−0″.04
3090	− .0275	1.0	− .958	−389	+ .0017	+ .04
3139	− .0232	1.0	− .985	−379	− .0018	− .04
4043	+ .0059	0.8	+ .530	−135	− .0020	− .04
4044	+ .0010	0.7	+ .530	−135	+ .0029	+ .05
4079	+ .0059	0.9	+ .382	−125	− .0016	− .03
4080	− .0002	0.7	+ .382	−125	+ .0045	+ .08
4262	+ .0048	1.0	− .518	− 69	+ .0017	+ .04
4370	+ .0064	1.0	− .735	− 52	+ .0010	+ .02
4371	+ .0070	1.0	− .735	− 52	+ .0004	+ .01
4463	+ .0106	1.0	− .948	− 26	− .0015	− .03
5403	+ .0410	1.0	+ .628	+223	− .0024	− .05
5404	+ .0381	1.0	+ .628	+223	+ .0005	+ .01
5422	+ .0386	1.0	+ .561	+228	+ .0002	.00
5423	+ .0399	0.7	+ .561	+228	− .0010	− .02
5648	+ .0432	1.0	− .662	+307	− .0011	− .02
5649	+ .0408	1.0	− .662	+307	+ .0013	+ .03
5819	+0.0462	1.0	−0.973	+366	+0.0005	+0.01

The normal equations are:

$$16.8c + 0.401\mu - 4.4241\pi = + 0.2393 \text{ mm.}$$
$$+ 103.1645\mu + 7.8308\pi = + 1.0249 \text{ mm.}$$
$$+ 8.6838\pi = + 0.0399 \text{ mm.}$$

from which:

$c = + 0.01495$ mm.

$\mu = + 0.00961$ mm. $= + 0''.1998$, or $+ 0''.729$ per year.

$\pi = + 0.00354$ mm. $= + \mathbf{0''.074 \pm 0''.010.}$

Probable error of plate of unit weight

$$\pm 0.00123 \text{ mm.} = \pm 0''.026.$$

β CYGNI ($19^h\ 26^m$; $+27°\ 45'$)

β Cygni is very well known to all users of telescopes on account of the great difference in color. Webb in his *Celestial Objects for Common Telescopes* says that it is, "One of the finest in the heavens." The brighter star is of yellow color of Kop type, and magnitude 3.26, while the fainter is of blue color of magnitude 5.36 and B9 type. The distance between the stars is 34″. Only twice have the stars been investigated for parallax. Chase by means of the Yale heliometer for brighter and fainter star found the parallax to be $-\ 0''.027 \pm 0''.039$ and $-\ 0''.028 \pm 0''.039$,

TABLE 1

PLATES OF β^2 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
8	1914 May 9	$-0^h.2$	M	0.7
11	May 10	−0.3	M	0.7*
12	May 10	−0.1	M	1.0
16	May 11	−0.4	M	0.6*
17	May 11	0.0	M	0.6*
250	Sept. 15	−0.2	M, G	0.8
268	Sept. 20	−0.3	M	0.8
309	Sept. 25	−0.1	Ol	0.8
312	Sept. 26	−0.5	M	0.7
313	Sept. 26	−0.1	M	1.0
371	Oct. 5	0.0	Ol	0.8
388	Oct. 11	+0.1	M	0.8
1239	1915 Apr. 23	−1.3	Ol	0.5*
1240	Apr. 23	−0.8	Ol	0.7*
1340	June 5	−0.9	M	0.9
1351	June 9	−1.1	Ol	0.9
1651	Sept. 11	−0.8	M	1.0
1652	Sept. 11	−0.4	M, A	0.9
1672	Sept. 13	−1.0	Ol	0.8
1673	Sept. 13	−0.6	Ol	0.8
1704	Sept. 16	−0.9	M	0.8

* One exposure.

respectively. Jacoby by means of Rutherfurd photographs at Columbia University has found a parallax for the brighter star of $+ 0''.61 \pm 0''.03$. Mr. Olivier measured the parallax of both stars. For the brighter he found the relative parallax of $- 0''.006 \pm 0''.010$, and for the fainter the result, $0''.000 \pm 0''.006$. For proper motions in right ascension the plates gave $- 0''.011$ and $- 0''.011$, while Boss found the results, $- 0''.011$ and $- 0''.003$, respectively.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.	
				β^1 Cygni.	β^2 Cygni.
	mm.	mm.	mm.		
1	0.16	−52.1	+17.0	+0.1849	+0.1830
2	.14	−47.7	−26.6	.2142	.2027
3	.23	+18.0	−36.3	.2255	.2191
4	.10	+31.3	+27.9	.1838	.1937
5	.14	+50.4	+18.2	+0.1916	+0.2015
β^1 Cygni	.24	− 0.4	− 2.2		
β^2 Cygni	0.13	+ 1.0	− 1.2		

The normal equations are:

$$13.0c + 2.288\mu - 2.7424\pi = - 0.1663 \text{ mm.}$$
$$+ 44.6775\mu - 5.3662\pi = - 0.0342 \text{ mm.}$$
$$+ 9.1201\pi = + 0.0339 \text{ mm.}$$

from which:

$c = - 0.01283$ mm.

$\mu = - 0.00014$ mm. $= - 0''.0030$, or $- 0''.011$ per year.

$\pi = - 0.00028$ mm. $= - \mathbf{0''.006 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00125 \text{ mm.} = \pm 0''.026.$$

TABLE 2

REDUCTIONS FOR β^1 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
8	−0.0133	0.9	+0.876	−247	+0.0006	+0″.01
11	− .0118	0.7	+ .868	−246	− .0009	− .02
12	− .0138	0.7	+ .868	−246	+ .0011	+ .02
250	− .0148	0.8	− .879	−118	+ .0024	+ .04
268	− .0102	0.5	− .914	−113	− .0022	− .03
309	− .0111	0.5	− .942	−108	− .0013	− .02
312	− .0127	0.4	− .947	−107	+ .0003	.00
313	− .0160	0.7	− .947	−107	+ .0036	+ .06
371	− .0113	0.5	− .978	− 98	− .0011	− .02
388	− .0090	0.8	− .986	− 92	− .0034	− .06
1239	− .0088	0.5	+ .992	+102	− .0044	− .06
1240	− .0117	0.7	+ .992	+102	− .0014	− .02
1340	− .0136	0.9	+ .586	+145	+ .0004	+ .01
1351	− .0160	0.9	+ .530	+149	+ .0028	+ .06
1651	− .0142	1.0	− .847	+243	+ .0013	+ .03
1652	− .0120	0.9	− .847	+243	− .0009	− .02
1672	− .0141	0.8	− .863	+245	+ .0012	+ .02
1673	−0.0116	0.8	−0.863	+245	−0.0013	− .02

The normal equations are:

$$16.6c + 1.481\mu - 3.7532\pi = + 0.0710 \text{ mm.}$$
$$+ 59.2205\mu - 8.8021\pi = - 0.0021 \text{ mm.}$$
$$+ 12.6962\pi = - 0.0148 \text{ mm.}$$

from which:

$c = + 0.00429$ mm.

$\mu = - 0.00014$ mm. $= - 0''.0030$, or $- 0''.011$ per year.

$\pi = + 0.00000$ mm. $= \mathbf{0''.000 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00096 \text{ mm.} = \pm 0''.020.$$

TABLE 3

REDUCTIONS FOR β^2 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
8	+0.0027	0.7	+0.876	−235	+0.0019	+0″.03
11	+ .0036	0.7	+ .868	−234	+ .0010	+ .02
12	+ .0043	1.0	+ .868	−234	+ .0003	+ .01
16	+ .0062	0.6	+ .860	−233	− .0016	− .02
17	+ .0058	0.6	+ .860	−233	− .0012	− .02
250	+ .0058	0.8	− .879	−106	− .0014	− .02
268	+ .0064	0.8	− .914	−101	− .0020	− .04
309	+ .0064	0.8	− .942	− 96	− .0020	− .04
312	+ .0028	0.7	− .947	− 95	+ .0016	+ .03
313	+ .0028	1.0	− .947	− 95	+ .0016	+ .03
371	+ .0046	0.8	− .978	− 86	− .0002	.00
388	+ .0031	0.8	− .986	− 80	+ .0013	+ .02
1239	+ .0080	0.5	+ .992	+114	− .0039	− .06
1240	+ .0052	0.7	+ .992	+114	− .0011	− .02
1340	+ .0019	0.9	+ .586	+157	+ .0022	+ .04
1351	+ .0033	0.9	+ .530	+161	+ .0008	+ .01
1651	+ .0035	1.0	− .847	+255	+ .0004	+ .01
1652	+ .0037	0.9	− .847	+255	+ .0002	.00
1672	+ .0051	0.8	− .863	+257	− .0012	− .02
1673	+ .0052	0.8	− .863	+257	− .0013	− .02
1704	+0.0024	0.8	−0.887	+260	+0.0015	+0.03

LALANDE 37120 ($19^h\ 29^m$; $+32°\ 59'$)

This star of magnitude 6.6, of type G, of proper motion 0″.52 has a considerable radial velocity amounting to − 162 km. per second. The parallax values published are: Chase from the Yale heliometer, + 0″.048 ± 0″.039, Allegheny by photography + 0″.027 ± 0″.010, while Adams with the spectrograph gives the value + 0″.060. Ten of the plates were measured by Mr. Briggs, and nine by Mr. Mitchell. The relative parallax + 0″.042 ± 0″.007 resulted, and a proper motion in right ascension − 0″.473 while the corresponding value from Porter is − 0″.472.

TABLE 1

PLATES OF LALANDE 37120—1

No.	Date.	Hour Angle.	Observers.	Weight.
3010	1916 Sept. 17	−0h3	M	1.0
3023	Sept. 18	−0.3	Ol	1.0
3031	Sept. 19	−0.8	M	1.0
3032	Sept. 19	−0.4	M	0.9
3929	1917 May 1	−1.5	L	0.8
3930	May 1	−1.2	L	1.0
4068	June 16	−0.5	A	1.0
4392	Sept. 10	−0.9	B, A	1.0
4393	Sept. 10	−0.5	A	1.0
4441	Sept. 19	−0.6	M	1.0
4442	Sept. 19	−0.3	M	0.8
5385	1918 May 18	−0.7	Ol	0.7
5386	May 18	−0.7	Ol	0.7
5472	June 22	−0.9	A	0.7
5473	June 22	−0.2	Ol	1.0
5728	Sept. 30	−0.5	M	1.0
5729	Sept. 30	−0.1	M	1.0
5750	Oct. 3	−0.3	M	1.0
5751	Oct. 3	0.0	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−45.5	−24.9	+0.1702
2	.12	−17.8	+10.6	.1553
3	.17	− 4.9	+46.6	.1359
4	.14	− 0.3	−21.3	.1800
5	.16	+22.5	−35.6	.1951
6	.09	+46.0	+24.6	+0.1635
Parallax star	0.14	+ 0.7	− 3.0	

TABLE 2

REDUCTIONS FOR LALANDE 37120—1

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3010	−0.0304	1.0	−0.891	−403	−0.0010	−0″.02
3023	− .0297	1.0	− .898	−402	− .0018	− .04
3031	− .0324	1.0	− .905	−401	+ .0008	+ .02
3032	− .0348	0.9	− .905	−401	+ .0032	+ .06
3929	− .0404	0.8	+ .933	−177	− .0014	− .02
3930	− .0412	1.0	+ .933	−177	− .0006	− .01
4068	− .0468	1.0	+ .431	−131	+ .0011	+ .02
4392	− .0524	1.0	− .832	− 45	− .0012	− .02
4393	− .0540	1.0	− .832	− 45	+ .0004	+ .01
4441	− .0554	1.0	− .903	− 36	+ .0011	+ .02
4442	− .0524	0.8	− .903	− 36	− .0019	− .04
5385	− .0694	0.7	+ .803	+205	+ .0035	+ .06
5386	− .0650	0.7	+ .803	+205	− .0009	− .01
5472	− .0676	0.7	+ .343	+240	− .0014	− .02
5473	− .0688	1.0	+ .343	+240	− .002	.00
5728	− .0794	1.0	− .960	+340	+ .0015	+ .03
5729	− .0758	1.0	− .960	+340	− .0021	− .04
5750	− .0793	1.0	− .970	+343	+ .0012	+ .02
5751	−0.0776	1.0	−0.970	+343	−0.0005	−0.01

The normal equations are:

$$17.6c - 1.103\mu - 6.8402\pi = -0.9702 \text{ mm.}$$
$$+ 133.2724\mu + 2.4145\pi = -0.7656 \text{ mm.}$$
$$+ 12.5900\pi = +0.3849 \text{ mm.}$$

from which:

$c = -0.05472$ mm.

$\mu = -0.00623$ mm. $= -0''.1297$, or $-0''.473$ per year.

$\pi = +0.00203$ mm. $= +\mathbf{0''.042 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00109 \text{ mm.} = \pm 0''.023.$$

θ CYGNI ($19^h\ 33^m$; $+49°\ 59'$)

This star is of 4.64 magnitude, and of type F5, with a proper motion amounting to 0″.25. It is a double, discovered by Burnham, β 1131, but the companion is of 14th magnitude, and in reach of the largest telescopes only. The parallax has been five times determined, with the following results:

Parallax.	Authority.	Method.
+0″.062±0″.025	Chase	Heliometer
+ .010± .026	Flint	Meridian Circle
+ .072± .026	Abetti	Meridian Circle
+ .057± .008	Allegheny	Photography
+0.069	Adams	Spectrograph

Mr. Olivier measured the McCormick plates.

TABLE 1

PLATES OF θ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
40	1914 May 23	−0^h.3	M	0.7
48	May 25	−0.7	M	0.7
49	May 25	−0.2	M	0.9
54	May 30	−0.2	M	1.0
297	Sept. 23	−0.6	M, G	1.0
325	Sept. 27	−0.7	M	1.0
326	Sept. 27	−0.3	M	0.9
374	Oct. 6	−0.2	M	0.7
378	Oct. 7	−0.2	M	1.0
380	Oct. 9	−0.2	M	0.7*
1247	1915 Apr. 24	−1.6	M	1.0
1248	Apr. 24	−1.2	M	0.7
1266	Apr. 30	−1.5	Ol	1.0
1267	Apr. 30	−1.1	Ol	0.4*
1268	Apr. 30	−0.6	Ol	0.7
1278	May 8	−1.9	M	0.7
1279	May 8	−1.5	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependénce.
	mm.	mm.	mm.	
1	0.14	−48.8	+15.3	+0.2485
2	.09	−22.3	−28.8	.2410
3	.10	+21.9	+35.3	.2605
4	.13	+49.2	−21.8	+0.2500
Parallax star	0.14	+ 0.5	+ 0.6	

TABLE 2

REDUCTIONS FOR θ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
40	+0.0047	0.7	+0.760	−188	−0.0002	0″.00
48	+ .0003	0.7	+ .738	−186	+ .0041	+ .07
49	+ .0056	0.9	+ .738	−186	− .0012	− .02
54	+ .0062	1.0	+ .680	−181	− .0020	− .04
297	− .0016	1.0	− .920	− 65	+ .0005	+ .01
325	− .0032	1.0	− .942	− 61	+ .0020	+ .04
326	− .0037	0.9	− .942	− 61	+ .0025	+ .05
374	+ .0032	0.7	− .974	− 52	− .0044	− .08
378	− .0004	1.0	− .977	− 51	− .0009	− .02
380	− .0005	0.7	− .980	− 49	− .0008	− .01
1247	+ .0114	1.0	+ .971	+148	− .0037	− .08
1248	+ .0046	0.7	+ .971	+148	+ .0031	+ .05
1266	+ .0051	1.0	+ .946	+154	+ .0026	+ .05
1267	+ .0046	0.4	+ .946	+154	+ .0031	+ .04
1268	+ .0069	0.7	+ .946	+154	+ .0008	+ .01
1278	+ .0078	0.7	+ .897	+162	− .0003	.00
1279	+0.0100	1.0	+0.897	+162	−0.0025	−0.05

The normal equations are:

$$14.1c - 0.624\mu + 2.5004\pi = + 0.0500 \text{ mm.}$$
$$+ 26.1980\mu + 6.4242\pi = + 0.0419 \text{ mm.}$$
$$+ 11.4114\pi = + 0.0560 \text{ mm.}$$

from which:

$c = +0.00289$ mm.

$\mu = +0.00072$ mm. $= +0''.0150$, or $+0''.055$ per year.

$\pi = +0.00387$ mm. $= +\mathbf{0''.080 \pm 0''.011}$.

Probable error of plate of unit weight

± 0.00161 mm. $= \pm 0''.034$.

α SAGITTÆ ($19^h\ 35^m$; $+17°\ 47'$)

The spectroscopic parallax $+0''.016$ has been found for this star, which is of G type, of magnitude 4.37, and of small annual proper

TABLE 1

PLATES OF α SAGITTÆ

No.	Date.	Hour Angle.	Observers.	Weight.
373	1914 Oct. 5	$+0^h.9$	Ol, G	1.0
386	Oct. 10	+0.4	M, A	1.0
396	Oct. 12	+0.4	Ol, G	0.7
397	Oct. 12	+1.4	G, Ol	1.0
1258	1915 Apr. 26	−1.2	G	0.7
1259	Apr. 26	−0.8	G	0.5*
1303	May 10	−0.8	G	0.7
1304	May 10	−0.2	G	0.7
1319	May 17	0.0	G	0.8
1397	June 26	−0.2	G	1.0
1398	June 26	+0.2	G	1.0
1719	Sept. 19	−0.6	M	0.8
1814	Oct. 11	+0.2	Ol	0.8
1827	Oct. 15	+0.8	G	0.9
3999	1917 May 23	−0.8	M	0.7*
4116	June 23	−0.4	Ol	0.8
4117	June 23	0.0	Ol	1.0
4372	Aug. 29	−0.3	A	0.8
4470	Sept. 26	+0.5	M	1.0
4486	Sept. 30	−0.1	M	1.0
4512	Oct. 3	+0.6	M	0.9
4513	Oct. 3	+1.0	M	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−46.9	+ 5.0	+0.1469
2	.23	−35.8	−36.8	.1748
3	.12	−29.6	−32.1	.1745
4	.16	+20.0	+38.5	.1517
5	.24	+37.1	− 5.1	.1830
6	.25	+55.2	+30.5	+0.1691
Parallax star	0.20	+ 0.9	− 1.2	

TABLE 2

REDUCTIONS FOR α SAGITTÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
373	+0.0044	1.0	−0.970	−489	+0.0015	+0″.03
386	+ .0082	1.0	− .980	−484	− .0023	− .05
396	+ .0058	0.7	− .983	−482	+ .0001	.00
397	+ .0054	1.0	− .983	−482	+ .0005	+ .01
1258	+ .0029	0.7	+ .965	−289	+ .0026	+ .04
1259	+ .0046	0.5	+ .965	−289	+ .0009	+ .01
1303	+ .0087	0.7	+ .886	−272	− .0032	− .05
1304	+ .0047	0.7	+ .886	−272	+ .0008	+ .01
1319	+ .0039	0.8	+ .827	−265	+ .0017	+ .03
1397	+ .0060	1.0	+ .307	−225	− .0001	.00
1398	+ .0063	1.0	+ .307	−225	− .0004	− .01
1719	+ .0071	0.8	− .888	−140	− .0005	− .01
1814	+ .0063	0.8	− .981	−118	+ .0004	+ .01
1827	+ .0080	0.9	− .983	−114	− .0012	− .02
3999	+ .0098	0.7	+ .792	+472	− .0025	− .04
4116	+ .0050	0.8	+ .346	+503	+ .0026	+ .05
4117	+ .0092	1.0	+ .346	+503	− .0016	− .03
4372	+ .0104	0.8	− .689	+570	− .0022	− .04
4470	+ .0108	1.0	− .935	+588	− .0025	− .05
4486	+ .0042	1.0	− .954	+592	+ .0042	+ .09
4512	+ .0068	0.9	− .965	+605	+ .0016	+ .03
4513	+0.0085	0.7	−0.965	+605	−0.0001	0.00

motion 0″.05. Twenty-two plates were measured, of which the first thirteen were measured by Mr. Graham and the balance by Mr. Mitchell. The proper motion in right ascension from the plates is + 0″.017 while the value from Boss is + 0″.016.

The normal equations are:

$$18.5c + 3.488\mu - 5.1340\pi = + 0.1246 \text{ mm.}$$
$$+ 342.1209\mu - 7.2639\pi = + 0.1047 \text{ mm.}$$
$$+ 13.0751\pi = - 0.0413 \text{ mm.}$$

from which:

$c = + 0.00656$ mm.
$\mu = + 0.00023$ mm. $= + 0''.0048$, or $+ 0''.017$ per year.
$\pi = - 0.00045$ mm. $= - \mathbf{0''.009 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00126 \text{ mm.} = \pm 0''.026.$$

16 CYGNI or BOSS 5037–8 ($19^h\ 39^m$; $+50°\ 17'$)

This is a double star of the type of 61 Cygni. The components are of nearly equal brightness 6.3 and 6.4, respectively, and their spectral types are F and F5. The two components are separated by 38″, and they have nearly the same proper motion about 20″ per year. Parallax measures have been made on this pair as follows:

Observer.	Method.	Boss 5037.	Boss 5038.	Mean.
Jost	Meridian Circle			+0″.153±0″.031
Slocum and Mitchell	Photography	+0″.043±0″.008	+0″.028±0″.009	+ .036± .006
Miller	Photography	+ .037± .012	+ .018± .006	+ .027± .006
Allegheny	Photography	+ .043± .006	+ .021± .012	+ .038± .006
Adams	Spectro-graph	+0.050	+0.044	+0.052

The McCormick plates were measured by Mr. Mitchell, and gave a mean parallax of:

$$\mathbf{+ 0''.033 \pm 0''.007}.$$

TABLE 1

PLATES OF 16 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
3164	1916 Oct. 11	-0^h2	M	1.0
3177	Oct. 12	−0.1	M	1.0
3188	Oct. 14	−0.1	M	1.0
3205	Oct. 17	0.0	M	1.0
3902	1917 Apr. 19	−1.3	M	1.0
4103	June 22	−0.4	A	1.0
4104	June 22	−0.1	A	0.7*
4405	Sept. 11	−1.2	M	1.0
4406	Sept. 11	−0.9	B	1.0
4455	Sept. 20	−0.8	M	1.0
4456	Sept. 20	−0.5	M	1.0
5408	1918 June 3	−0.5	A	1.0
5409	June 3	−0.1	A	1.0
5487	June 27	−0.3	Ol	1.0
5742	Oct. 2	−0.4	M	0.8
5743	Oct. 2	−0.1	M	1.0
5756	Oct. 4	−0.4	M	1.0
5757	Oct. 4	0.0	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.	
				Boss 5037.	Boss 5038.
	mm.	mm.	mm.		
1	0.08	−42.7	+41.4	+0.194	+0.201
2	.10	−38.9	−14.1	.201	.184
3	.10	+ 5.4	−22.5	.203	.195
4	.12	+26.3	−25.6	.204	.199
5	.08	+49.9	+20.8	+0.198	+0.221
Boss 5037	.12	+ 0.3	− 0.5		
Boss 5038	0.10	+ 1.6	+ 0.8		

A combination of the three parallax determinations by photography, Yerkes, Swarthmore, Allegheny and McCormick are in excellent agreement and give the mean parallax of:

$$+ 0''.033 \pm 0''.003.$$

The proper motions determined from the photographic plates at McCormick Observatory in right ascension were, $-0''.143$ and $-0''.123$, while the corresponding values from Boss were $-0''.155$ and $-0''.132$, respectively.

TABLE 2

REDUCTIONS FOR BOSS 5037

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3164	+0.0212	1.0	−0.980	−377	+0.0017	+0″.04
3177	+ .0244	1.0	− .981	−376	− .0015	− .03
3188	+ .0228	1.0	− .982	−374	+ .0001	.00
3205	+ .0227	1.0	− .982	−371	+ .0001	.00
3902	+ .0216	1.0	+ .984	−187	+ .0012	+ .02
4103	+ .0168	1.0	+ .373	−123	+ .0037	+ .08
4104	+ .0241	0.7	+ .373	−123	− .0036	− .06
4405	+ .0172	1.0	− .818	− 42	− .0003	− .01
4406	+ .0192	1.0	− .818	− 42	− .0023	− .05
4455	+ .0152	1.0	− .892	− 33	+ .0014	+ .03
4456	+ .0185	1.0	− .892	− 33	− .0019	− .04
5408	+ .0182	1.0	+ .646	+223	− .0037	− .08
5409	+ .0143	1.0	+ .646	+223	+ .0002	.00
5487	+ .0117	1.0	+ .299	+247	+ .0017	+ .04
5742	+ .0079	0.8	− .956	+344	+ .0015	+ .03
5743	+ .0097	1.0	− .956	+344	− .0003	− .01
5756	+ .0091	1.0	− .964	+346	+ .0003	+ .01
5757	+0.0084	1.0	−0.964	+346	+0.0010	+0.02

The normal equations are:

$$17.5c - 0.399\mu - 7.7847\pi = + 0.2942 \text{ mm.}$$
$$+ 124.0320\mu + 4.3841\pi = - 0.2323 \text{ mm.}$$
$$+ 12.4135\pi = - 0.1231 \text{ mm.}$$

from which:

$c = + 0.01755$ mm.

$\mu = - 0.00188$ mm. $= - 0''.0391$, or $- 0''.143$ per year.

$\pi = + 0.00175$ mm. $= + \mathbf{0''.036 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00135 \text{ mm.} = \pm 0''.028.$$

TABLE 3

REDUCTIONS FOR BOSS 5038

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3164	+0.0026	1.0	−0.980	−377	+0.0015	+0″.03
3177	+ .0026	1.0	− .981	−376	+ .0015	+ .03
3188	+ .0048	1.0	− .982	−374	− .0008	− .02
3205	+ .0029	1.0	− .982	−371	+ .0011	+ .02
3902	+ .0028	1.0	+ .984	−187	+ .0011	+ .02
4103	+ .0009	1.0	+ .373	−123	+ .0011	+ .02
4104	+ .0035	0.7	+ .373	−123	− .0015	− .03
4405	+ .0013	1.0	− .818	− 42	− .0024	− .05
4406	+ .0032	1.0	− .818	− 42	− .0043	− .09
4455	.0000	1.0	− .892	− 33	− .0013	− .03
4456	− .0018	1.0	− .892	− 33	+ .0005	+ .01
5408	− .0008	1.0	+ .646	+223	− .0024	− .05
5409	− .0020	1.0	+ .646	+223	− .0012	− .02
5487	− .0080	1.0	+ .299	+247	+ .0039	+ .08
5742	− .0126	0.8	− .956	+344	+ .0051	+ .09
5743	− .0064	1.0	− .956	+344	− .0011	− .02
5756	− .0078	1.0	− .964	+346	+ .0002	.00
5757	−0.0073	1.0	−0.964	+346	−0.0003	−0.01

The normal equations are:

$$17.5c - 0.399\mu - 7.7847\pi = -0.0206 \text{ mm.}$$
$$+ 124.0320\mu + 4.3841\pi = -0.1939 \text{ mm.}$$
$$+ 12.4135\pi = +0.0154 \text{ mm.}$$

from which:

$c = -0.00057$ mm.

$\mu = -0.00162$ mm. $= -0''.0336$, or $-0''.123$ per year.

$\pi = +0.00145$ mm. $= +\mathbf{0''.030 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00156 \text{ mm.} = \pm 0''.032.$$

γ AQUILÆ ($19^h\ 41^m$; $+10°\ 22'$)

Two values of the parallax have been published, the meridian circle result of Flint giving the parallax $-0''.009 \pm 0''.033$, and

TABLE 1

PLATES OF γ AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
376	1914 Oct. 6	+0^{h}8	M	0.6
403	Oct. 18	+0.7	M	0.5*
404	Oct. 18	+1.0	M	0.8
466	Nov. 2	+0.9	M	0.8
1295	1915 May 9	−0.5	A	1.0
1343	June 6	−0.6	A	1.0
1391	June 25	−0.5	A	1.0
1392	June 25	−0.1	A	0.7*
1405	June 27	−0.4	A	0.9
1406	June 27	0.0	A	0.9
1615	Sept. 7	+0.5	A	0.9
1616	Sept. 7	+1.0	A	0.8
1622	Sept. 8	+0.3	A	1.0
1623	Sept. 8	+0.7	A	0.7*
4035	1917 June 4	−0.5	A	0.9
4036	June 4	−0.2	A	1.0
4070	June 16	+0.1	A	1.0
4071	June 16	+0.4	A	0.8
4336	Aug. 25	+0.4	A	0.8
4337	Aug. 25	+0.7	A	0.9
4396	Sept. 10	+0.2	A	1.0
4397	Sept. 10	+0.4	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−62.4	+60.8	+0.2744
2	.10	−11.0	−37.7	.2497
3	.19	+10.5	−25.0	.2445
4	.14	+62.9	+ 1.9	+0.2314
Parallax star	0.19	− 2.8	+ 1.6	

the spectroscopic parallax of Adams with the value + 0″.020. The star is of K2 type, of magnitude 2.80, and of small proper motion, 0″.014. Mr. Alden measured the McCormick plates, and obtained the proper motion in right ascension of + 0″.001 while the value from Boss is + 0″.013.

TABLE 2

REDUCTIONS FOR γ AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
376	−0.0108	0.6	−0.967	−503	−0.0010	−0″.01
403	− .0108	0.5	− .981	−491	− .0010	− .01
404	− .0122	0.8	− .981	−491	+ .0004	+ .01
466	− .0086	0.8	− .940	−476	− .0031	− .06
1295	− .0074	1.0	+ .902	−288	− .0017	− .04
1343	− .0084	1.0	+ .620	−260	− .0011	− .02
1391	− .0123	1.0	+ .346	−241	+ .0024	+ .05
1392	− .0115	0.7	+ .346	−241	+ .0016	+ .03
1405	− .0092	0.9	+ .314	−239	− .0007	− .01
1406	− .0090	0.9	+ .314	−239	− .0009	− .02
1615	− .0144	0.9	− .761	−167	+ .0030	+ .06
1616	− .0140	0.8	− .761	−167	+ .0026	+ .05
1622	− .0136	1.0	− .777	−166	+ .0022	+ .05
1623	− .0095	0.7	− .777	−166	− .0019	− .03
4035	− .0094	0.9	+ .638	+469	.0000	.00
4036	− .0131	1.0	+ .638	+469	+ .0037	+ .08
4070	− .0064	1.0	+ .473	+481	− .0032	− .07
4071	− .0106	0.8	+ .473	+481	+ .0010	+ .02
4336	− .0110	0.8	− .620	+551	− .0001	.00
4337	− .0062	0.9	− .620	+551	− .0049	− .10
4396	− .0132	1.0	− .802	+567	+ .0019	+ .04
4397	−0.0111	1.0	−0.802	+567	−0.0002	0.00

The normal equations are:

$$19.0c + 5.527\mu - 3.1411\pi = - 0.2006 \text{ mm.}$$
$$+ 308.6303\mu + 5.0129\pi = - 0.0446 \text{ mm.}$$
$$+ 9.2248\pi = + 0.0453 \text{ mm.}$$

from which:

$c = -0.01033$ mm.
$\mu = +0.00002$ mm. $= +0''.0004$, or $+0''.001$ per year.
$\pi = +0.00138$ mm. $= +$ **0″.029 ± 0″.011.**

Probable error of plate of unit weight

$$\pm 0.00149 \text{ mm.} = \pm 0''.031.$$

17 CYGNI ($19^h\ 42^m$; $+33°\ 29'$)

This star is called χ Cygni, and should not be confused with the well known variable. It is a star of 5.03 magnitude, and of F5 type. It has a fairly large proper motion of 0″.45, which motion is almost entirely in declination. This proper motion is shared by a star of 8.1 magnitude and at a distance of 25″.7. The two, known as Σ 2580, accordingly, form a physical system. 812″ distant from this pair is the double Σ 2576, the components of which are separated by 2″.5. This second pair has almost the same proper motion as Σ 2580. All four stars thus have the same proper motion, though so widely separated. This common proper motion signifies a physical system, and all four should show the same parallax. The plates were measured by Mr. Mitchell. The double Σ 2576 have components of the same magnitude. The stars were not separated on the plates, and the center of the elongated image was measured. This gave rise to no inaccuracy on account of the equality in the size of the images. The parallaxes and proper motions in right ascension determined from the photographs follow:

Star.	Parallax.	Proper Motion in Right Ascension.
Σ 2580, A	+0″.057±0″.009	−0″.007
Σ 2580, B	+ .042± .008	+ .007
Σ 2576, AB	+ .036± .008	− .034

On the assumption that these four stars form a physical system, the parallax derived from the above is

$$+ 0''.045 \pm 0''.004.$$

The spectroscopic values of the three stars are +0″.042, +0″.063 and + 0″.036, with an average value of + 0″.047.

The parallax of the brighter star of 17 Cygni by Chase with the Yale heliometer gives the result + 0″.01 ± 0″.026, while Allegheny finds + 0″.030 ± 0″.007. With the McCormick value of the parallax, stars A and B of Σ 2580 are separated by 570 astronomical units, and this pair from Σ 2576 by the enormous distance of 18,000 times that separating earth from sun!

TABLE 1

PLATES OF 17 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
31	1914 May 19	−0h5	M	0.9
32	May 19	0.0	M	0.9
35	May 22	−0.5	M	0.8
36	May 22	0.0	M	0.9
269	Sept. 20	−0.1	M	0.5*
293	Sept. 22	+0.1	M	1.0
337	Sept. 28	−0.1	M, G	1.0
347	Sept. 29	−0.2	M, A	1.0
385	Oct. 10	−0.3	M	1.0
402	Oct. 18	0.0	M	0.9
1270	1915 May 1	−0.8	M	0.9
1280	May 8	−1.0	M	0.9
1281	May 8	−0.7	M	0.9
1293	May 9	−1.5	A	0.8
1294	May 9	−1.1	A	1.0
4090	1917 June 18	−0.7	M	0.9
4091	June 18	−0.4	M	0.8
4132	June 29	−0.1	A	0.9
4346	Aug. 26	−0.6	A	0.7
4347	Aug. 26	−0.3	A	0.9
4468	Sept. 26	−0.4	M	0.5*
4469	Sept. 26	−0.1	M	0.5*
4511	Oct. 3	0.0	M	0.7
4514	Oct. 4	−0.1	M	0.7

* One exposure.

TABLE 2

REDUCTIONS FOR Σ 2580, A

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
31	−0.0007	0.7	+0.821	−553	+0.0015	+0″.02
32	+ .0046	0.7	+ .821	−553	− .0038	− .07
35	+ .0043	0.7	+ .792	−550	− .0036	− .06
36	− .0022	0.7	+ .792	−550	+ .0029	+ .05
269	− .0027	0.5	− .883	−429	− .0013	− .02
293	− .0054	1.0	− .897	−427	+ .0013	+ .03
337	− .0064	1.0	− .933	−421	+ .0022	+ .05
347	− .0057	1.0	− .938	−420	+ .0015	+ .03
385	− .0057	1.0	− .975	−409	+ .0014	+ .03
402	+ .0010	0.7	− .981	−401	− .0053	− .09
1270	+ .0031	0.8	+ .950	−206	− .0023	− .04
1280	+ .0017	0.8	+ .910	−199	− .0010	− .02
1281	− .0016	0.7	+ .910	−199	+ .0023	+ .04
1293	+ .0031	0.5	+ .904	−198	− .0024	− .04
1294	− .0016	1.0	+ .904	−198	+ .0022	+ .05
4090	− .0016	0.9	+ .448	+573	+ .0002	.00
4091	− .0045	0.8	+ .448	+573	+ .0032	+ .06
4132	− .0023	0.9	+ .278	+584	+ .0005	+ .01
4346	− .0002	0.7	− .629	+642	− .0042	− .07
4347	− .0056	0.8	− .629	+642	+ .0012	+ .02
4468	− .0041	0.5	− .923	+673	− .0011	− .02
4469	− .0065	0.5	− .923	+673	+ .0013	+ .02
4511	− .0050	0.7	− .956	+680	− .0003	− .01
4514	−0.0038	0.7	−0.960	+681	−0.0015	−0.03

COMPARISON STARS FOR 17 CYGNI = Σ 2580

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependences.	
				Σ 2580, A.	Σ 2580, B
	mm.	mm.	mm.		
3	0.16	−36.3	+ 6.8	.+0.190	+0.176
4	.07	+ 5.0	− 3.6	.200	.201
5	.14	+11.0	−43.6	.178	.171
6	.16	−19.4	+35.3	.214	.215
7	.13	+39.7	+ 5.1	+0.218	+0.237
Σ 2580, A	.27	+ 0.6	+ 1.4		
Σ 2580, B	0.10	+ 1.7	+ 1.9		

COMPARISON STARS FOR Σ 2576

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−33.5	− 1.3	+0.223
2	.21	−30.3	−14.2	.234
3	.16	− 8.3	+25.5	.181
4	.07	+33.0	+15.0	.164
5	.14	+39.1	−25.0	+0.198
Σ 2576	0.18	− 2.9	− 1.5	

The normal equations are:

$$18.3c - 3.883\mu - 1.3279\pi = -0.0402 \text{ mm.}$$
$$+ 449.6218\mu - 14.6590\pi = -0.0766 \text{ mm.}$$
$$+ 12.7219\pi = +0.0390 \text{ mm.}$$

from which:

$c = -0.00202$ mm.

$\mu = -0.00010$ mm. $= -0''.0020$, or $-0''.007$ per year.

$\pi = +0.00274$ mm. $= +\mathbf{0''.057} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00147 \text{ mm.} = \pm 0''.031.$$

TABLE 3

REDUCTIONS FOR Σ 2580, B

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
31	+0.0043	1.0	+0.821	−553	−0.0018	−0″.04
32	+ .0029	1.0	+ .821	−553	− .0004	− .01
35	+ .0025	0.9	+ .792	−550	.0000	.00
36	+ .0023	1.0	+ .792	−550	+ .0002	.00
269	+ .0016	0.5	− .883	−429	− .0024	− .04
293	+ .0010	1.0	− .897	−427	− .0018	− .04
337	− .0018	1.0	− .933	−421	+ .0009	+ .02
347	− .0026	1.0	− .938	−420	+ .0017	+ .04
385	− .0027	1.0	− .975	−409	+ .0017	+ .04
402	+ .0011	1.0	− .981	−401	− .0021	− .04
1270	+ .0028	1.0	+ .950	−206	+ .0003	+ .01
1280	+ .0058	1.0	+ .910	−199	− .0028	− .06
1281	+ .0015	1.0	+ .910	−199	+ .0016	+ .03
1293	+ .0022	1.0	+ .904	−198	+ .0008	+ .02
1294	− .0011	1.0	+ .904	−198	+ .0041	+ .09
4090	+ .0069	0.9	+ .448	+573	− .0040	− .08
4091	+ .0022	0.8	+ .448	+573	+ .0006	+ .01
4132	+ .0022	0.9	+ .278	+584	+ .0003	+ .01
4346	+ .0001	0.7	− .629	+642	+ .0006	+ .01
4347	+ .0007	1.0	− .629	+642	.0000	.00
4468	+ .0018	0.5	− .923	+673	− .0016	− .02
4469	− .0038	0.5	− .923	+673	+ .0040	+ .06
4511	+ .0031	0.7	− .956	+680	− .0030	− .05
4514	−0.0027	0.7	−0.960	+681	+0.0028	+0.05

The normal equations are:

$$21.1c - 12.267\mu + 0.2376\pi = + 0.0288 \text{ mm.}$$
$$+ 500.9517\mu - 21.3804\pi = - 0.0126 \text{ mm.}$$
$$+ 14.8109\pi = + 0.0282 \text{ mm.}$$

from which:

$c = + 0.00140$ mm.

$\mu = + 0.00010$ mm. $= + 0''.0020$, or $+ 0''.007$ per year.

$\pi = + 0.00202$ mm. $= + \mathbf{0''.042 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00136 \text{ mm.} = \pm 0''.028.$$

TABLE 4

REDUCTIONS FOR Σ 2576

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
31	+0.0156	1.0	+0.821	−553	+0.0011	+0″.02
32	+ .0182	1.0	+ .821	−553	− .0015	− .03
35	+ .0151	0.9	+ .792	−550	+ .0015	+ .03
36	+ .0212	1.0	+ .792	−550	− .0046	− .10
269	+ .0102	0.5	− .883	−429	+ .0030	+ .04
293	+ .0148	1.0	− .897	−427	− .0017	− .04
337	+ .0102	1.0	− .933	−421	+ .0028	+ .06
347	+ .0129	1.0	− .938	−420	+ .0001	.00
385	+ .0132	1.0	− .975	−409	− .0003	− .01
402	+ .0143	1.0	− .981	−401	− .0014	− .03
1270	+ .0189	1.0	+ .950	−206	− .0036	− .07
1280	+ .0164	1.0	+ .910	−199	− .0012	− .02
1281	+ .0126	1.0	+ .910	−199	+ .0026	+ .05
1293	+ .0125	1.0	+ .904	−198	+ .0027	+ .06
1294	+ .0116	1.0	+ .904	−198	+ .0036	+ .07
4090	+ .0108	0.9	+ .448	+573	.0000	.00
4091	+ .0115	0.8	+ .448	+573	− .0007	− .01
4132	+ .0107	0.9	+ .278	+584	− .0002	.00
4346	+ .0108	0.7	− .629	+642	− .0022	− .04
4347	+ .0063	1.0	− .629	+642	+ .0024	+ .05
4468	+ .0071	0.5	− .923	+673	+ .0009	+ .01
4469	+ .0093	0.5	− .923	+673	− .0013	− .02
4511	+ .0064	0.7	− .956	+680	+ .0015	+ .03
4514	+0.0111	0.7	−0.960	+681	−0.0032	−0.06

The normal equations are:

$$21.1c - 12.267\mu + 0.2376\pi = + 0.2740 \text{ mm.}$$
$$+ 500.9517\mu - 21.3804\pi = - 0.4240 \text{ mm.}$$
$$+ 14.8109\pi = + 0.0383 \text{ mm.}$$

from which:

$c = + 0.01270$ mm.

$\mu = - 0.00046$ mm. $= - 0''.0096$, $= - 0''.034$ per year.

$\pi = + 0.00171$ mm. $= + \mathbf{0''.036} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

32 ± 0.00150 mm. $= \pm 0''.031$.

α AQUILÆ ($19^h\ 45^m$; $+8°\ 36'$)

Altair, of 0.89 magnitude, of A5 type, and of fairly large proper motion 0″.65, has had its parallax many times observed with the following results:

Parallax.	Authority.	Method.
+0″.232±0″.019	Elkin	Heliometer
.22 ± .047	Flint	Meridian Circle
.079± .033	Flint	Meridian Circle
+0.216± .073	Jewdokimov	Meridian Circle

Combining the McCormick result, where $\pi = +\ 0''.218 \pm 0''.007$, weighting the values according to their probable errors, and omitting the second value of Flint, above, then the parallax of Altair results:

$$\pi = +\ 0''.220.$$

The McCormick plates were measured by Mr. Mitchell. The proper motion in right ascension from the plates is + 0″.536, while the value from Boss is + 0″.544. These results have already been published in *Popular Astronomy*, **25**, 1, 1917.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−44.7	+21.8	+0.182
2	.14	−28.2	−48.4	.221
3	.12	+11.8	− 4.5	.204
4	.14	+16.8	+50.7	.176
5	.12	+44.3	−19.6	+0.217
Parallax star	0.19	+ 0.6	− 3.0	

TABLE 1

PLATES OF ALTAIR

No.	Date.	Hour Angle.	Observers.	Weight.
1417	1915 June 30	0h0	G	0.8
1418	June 30	+0.4	G	0.7
1426	July 2	+0.3	A	0.7
1427	July 2	+0.8	A	0.9
1653	Sept. 11	−0.2	A	0.6
1654	Sept. 11	+0.1	A	0.9
1665	Sept. 12	−0.3	M	0.6
1720	Sept. 19	−0.2	M	1.0
1732	Sept. 22	−0.2	A	1.0
1760	Sept. 25	−0.7	M	1.0
1761	Sept. 25	−0.2	M	1.0
2679	1916 May 27	−0.7	M	0.5
2680	May 27	−0.4	M	0.7
2694	June 1	−0.7	M	0.8
2695	June 1	−0.4	M	0.7
2753	June 22	−0.6	M	0.8
3046	Sept. 20	−0.2	M	0.8
3114	Sept. 30	−0.2	A	0.8
3119	Oct. 1	−0.2	M	0.7*
3120	Oct. 1	+0.2	M	0.7*
3178	Oct. 12	+0.2	M	1.0
3250	Oct. 23	+0.1	M	1.0
3251	Oct. 23	+0.4	M	0.8

* One exposure.

TABLE 2

REDUCTIONS FOR ALTAIR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1417	+0.0240	0.8	+0.283	−240	−0.0029	−0″.05
1418	+ .0186	0.7	+ .283	−240	+ .0025	+ .04
1426	+ .0186	0.7	+ .251	−238	+ .0023	+ .04
1427	+ .0214	0.9	+ .251	−238	− .0005	− .01
1653.	+ .0185	0.6	− .795	−167	− .0035	− .05
1654	+ .0148	0.9	− .795	−167	+ .0002	.00
1665	+ .0146	0.6	− .805	−166	+ .0004	+ .01
1720	+ .0170	1.0	− .866	−159	− .0021	− .04
1732	+ .0150	1.0	− .888	−156	− .0001	.00
1760	+ .0130	1.0	− .908	−153	+ .0019	+ .04
1761	+ .0134	1.0	− .908	−153	+ .0015	+ .03
2679	+ .0494	0.5	+ .743	+ 92	+ .0004	+ .01
2680	+ .0500	0.7	+ .743	+ 92	− .0002	.00
2694	+ .0496	0.8	+ .686	+ 97	.0000	.00
2695	+ .0500	0.7	+ .686	+ 97	− .0004	− .01
2753	+ .0481	0.8	+ .397	+118	.0000	.00
3046	+ .0420	0.8	− .879	+208	− .0009	− .02
3114	+ .0425	0.8	− .940	+218	− .0013	− .02
3119	+ .0412	0.7	− .945	+219	.0000	.00
3120	+ .0393	0.7	− .945	+219	+ .0019	+ .03
3178	+ .0398	1.0	− .977	+230	+ .0019	+ .04
3250	+ .0422	1.0	− .974	+241	+ .0003	+ .01
3251	+0.0444	0.8	−0.974	+241	−0.0019	−0.03

The normal equations are:

$$18.5c - 0.504\mu - 7.6896\pi = + 0.5704 \text{ mm.}$$
$$+ 66.4464\mu - 3.9192\pi = + 0.4187 \text{ mm.}$$
$$+ 11.4770\pi = - 0.1797 \text{ mm.}$$

from which:

$c = + 0.03540$ mm.

$\mu = + 0.00719$ mm. $= + 0''.1496$, or $+ 0''.546$ per year.

$\pi = + 0.10513$ mm. $= + \mathbf{0''.218} \pm \mathbf{0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00100 \text{ mm.} = \pm 0''.021.$$

η AQUILÆ ($19^h\ 47^m$; $+0°\ 45'$)

This is a well-known variable of small proper motion 0″.012, and of Go type. The range of light variation is from 3.7 to 4.4 magnitude. η Aquilæ has been found by Belopolsky to be a spectroscopic binary (*Astrophysical Journal*, **6**, 393, 1897),

TABLE 1

PLATES OF η AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
381	1914 Oct. 9	+0h.4	G	0.9
1434	1915 July 6	0.0	A	1.0
1743	Sept. 23	−0.3	M, G	0.8
1755	Sept. 24	−0.4	A	0.8
1756	Sept. 24	+0.3	A, Ol	0.6*
1916	Oct. 30	+0.7	M	1.0
1917	Oct. 30	+1.2	M	1.0
2736	1916 June 19	−0.8	M	0.8
2737	June 19	−0.4	M	0.9
2764	June 23	−0.3	Ol	0.7
2765	June 23	+0.2	Ol	0.8
2771	June 25	−0.8	M	0.6*
2939	Aug. 30	+0.6	A	0.6*
3078	Sept. 24	+0.4	M	1.0
3079	Sept. 24	+0.8	M	0.8
3115	Sept. 30	+0.3	A	1.0
3116	Sept. 30	+0.9	A	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−37.0	−15.4	+0.1751
2	.09	−32.0	− 2.1	.1774
3	.12	−25.8	+ 8.1	.1783
4	.21	− 8.9	− 7.8	.1675
5	.17	+42.6	−14.7	.1469
6	.22	+61.1	+31.9	+0.1548
Parallax star	0.22	− 2.5	− 0.2	

with a period of 7.176 days. It is a Cepheid variable, and according to Shapley has a theoretical absolute parallax + 0″.005. The only parallax is the spectroscopic value of Adams + 0″.003. The McCormick plates were measured by Mr. Alden who finds a proper motion in right ascension to be + 0″.018 while the value from Boss is + 0″.008.

TABLE 2

REDUCTIONS FOR η AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
381	+0.0064	0.9	−0.969	−516	−0.0009	−0″.02
1434	+ .0064	1.0	+ .193	−246	− .0003	− .01
1743	+ .0064	0.8	− .892	−167	− .0001	.00
1755	+ .0050	0.8	− .899	−166	+ .0013	+ .02
1756	+ .0054	0.6	− .899	−166	+ .0009	+ .01
1916	+ .0069	1.0	− .957	−130	− .0005	− .01
1917	+ .0054	1.0	− .957	−130	+ .0010	+ .02
2736	+ .0091	0.8	+ .447	+103	− .0022	− .04
2737	+ .0055	0.9	+ .447	+103	+ .0014	+ .03
2764	+ .0095	0.7	+ .387	+107	− .0026	− .04
2765	+ .0060	0.8	+ .387	+107	+ .0009	+ .02
2771	+ .0035	0.6	+ .356	+109	+ .0034	+ .05
2939	+ .0074	0.6	− .667	+175	− .0003	.00
3078	+ .0058	1.0	− .904	+200	+ .0014	+ .03
3079	+ .0079	0.8	− .904	+200	− .0007	− .01
3115	+ .0076	1.0	− .938	+206	− .0004	− .01
3116	+0.0088	0.9	−0.938	+206	−0.0016	−0.03

The normal equations are:

$$14.2c - 0.790\mu - 6.8209\pi = + 0.0947 \text{ mm.}$$
$$+ 60.8177\mu + 3.8050\pi = + 0.0091 \text{ mm.}$$
$$+ 8.5320\pi = - 0.0450 \text{ mm.}$$

from which:

$c = + 0.00665$ mm.

$\mu = + 0.00024$ mm. $= + 0''.0050$, or $+ 0''.018$ per year.

$\pi = - 0.00007$ mm. $= - \mathbf{0''.001 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00093 \text{ mm.} = \pm 0''.019.$$

ξ AQUILÆ ($19^h\ 49^m$; $+8°\ 12'$)

The spectroscopic parallax + 0″.008 has been found for this star which is of 4.86 magnitude, of G5 type, and of small proper motion 0″.10 per year. The McCormick plates were measured by Mr. Olivier. The proper motion in right ascension from the plates is + 0″.095 per year, and the value from Boss + 0″.095.

TABLE 1

PLATES OF ξ AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
1721	1915 Sept. 19	+0^h.5	M	0.9
1722	Sept. 19	+0.9	M	0.8
1825	Oct. 15	−0.1	Ol	0.7
1826	Oct. 15	+0.3	Ol, G	0.8
2891	1916 Aug. 18	+0.3	Ol	0.8
3024	Sept. 18	0.0	Ol	1.0
3025	Sept. 18	+0.5	Ol	0.7*
3977	1917 May 18	−0.4	Ol	0.9
4017	May 25	+0.2	Ol	1.0
4023	May 29	−0.8	Ol	0.9
4024	May 29	−0.2	Ol	0.8
4420	Sept. 12	−0.4	Ol	0.9
4421	Sept. 12	+0.1	Ol	0.9
4488	Oct. 1	+0.4	Ds A	1.0
4489	Oct. 1	+0.8	Ds A	1.0
4498	Oct. 2	−0.5	Ol	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−33.3	+34.1	+0.2234
2	.16	−20.1	−49.2	.3079
3	.11	− 3.2	+17.7	.1829
4	.10	+11.2	+16.6	.1544
5	.12	+45.4	−19.2	+0.1314
Parallax star	0.17	− 6.52	− 4.25	

TABLE 2

REDUCTIONS FOR ξ AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1721	−0.0111	0.9	−0.858	−444	+0.0026	+0″.05
1722	− .0084	0.8	− .858	−444	− .0001	.00
1825	− .0073	0.7	− .977	−428	− .0012	− .02
1826	− .0064	0.8	− .977	−428	− .0021	− .04
2891	− .0025	0.8	− .500	−120	− .0014	− .02
3024	− .0037	1.0	− .856	− 89	− .0004	− .01
3025	− .0067	0.7	− .856	− 89	+ .0026	+ .05
3977	+ .0032	0.9	+ .849	+153	− .0014	− .03
4017	+ .0006	1.0	+ .775	+160	+ .0011	+ .02
4023	+ .0002	0.9	+ .732	+164	+ .0015	+ .03
4024	+ .0030	0.8	+ .732	+164	− .0013	− .02
4420	+ .0003	0.9	− .801	+270	+ .0002	.00
4421	+ .0017	0.9	− .801	+270	− .0012	− .02
4488	− .0020	1.0	− .939	+289	+ .0025	+ .05
4489	+ .0017	1.0	− .939	+289	− .0012	− .02
4498	+0.0015	0.9	−0.943	+290	−0.0010	−0.02

The normal equations are:

$$14.0c + 2.574\mu - 6.1643\pi = - 0.0284 \text{ mm.}$$
$$+ 110.1236\mu + 7.1920\pi = + 0.1453 \text{ mm.}$$
$$+ 10.0078\pi = + 0.0349 \text{ mm.}$$

from which:

$c = - 0.00154$ mm.

$\mu = + 0.00125$ mm. $= + 0''.0260$, $= 0''.095$ per year.

$\pi = + 0.00164$ mm. $= + \mathbf{0''.034 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00109 \text{ mm.} = \pm 0''.023.$$

β AQUILÆ ($19^h\ 50^m$; $+6°\ 9'$)

Adams has found the spectroscopic parallax of this star to be $+ 0''.115$. Allegheny and Swarthmore by photography have

found the values + 0″.078 ± 0″.005 and + 0″.067 ± 0″.011, each in close agreement with the McCormick value. The star is of Ko type, of magnitude 3.90, and of annual proper motion 0″.484. Mr. Mitchell measured the McCormick plates, and found the proper motion in right ascension to be + 0″.018 while the value from Boss is + 0″.035.

TABLE 1

PLATES OF β AQUILÆ

No.	Date.	Hour Angle.	Observers.	Weight.
60	1914 May 31	−0h8	M	1.0
61	May 31	−0.3	M	0.9
83	June 19	−0.2	M, Ol	0.9
84	June 19	+0.3	M, Ol	0.4
240	Sept. 14	+0.7	M, A	1.0
241	Sept. 14	+1.1	M, A	1.0
261	Sept. 19	+1.2	M, A	0.9
415	Oct. 21	+0.7	M, Ol	0.7
434	Oct. 30	+1.0	A	1.2*
447	Oct. 31	+0.8	M	1.0
460	Nov. 1	+0.7	M	1.0
1312	1915 May 13	−0.7	M	1.0
1313	May 13	−0.3	M	1.0
1328	May 22	−0.8	M	1.0
1344	June 6	−0.2	A	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−49.3	+23.1	+0.156
2	.15	−48.2	−36.1	.181
3	.19	−10.4	+34.8	.152
4	.16	+22.8	−42.0	.184
5	.20	+25.3	+30.3	.155
6	.12	+59.8	−10.1	+0.172
Parallax star	0.16	+ 0.4	− 2.4	

TABLE 2

REDUCTIONS FOR β AQUILÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
60	−0.0186	1.0	+0.716	−156	+0.0012	+0″.02
61	− .0169	0.9	+ .716	−156	− .0005	− .01
83	− .0158	0.9	+ .465	−137	− .0023	− .05
84	− .0184	0.4	+ .465	−137	+ .0003	.00
240	− .0265	1.0	− .815	− 50	+ .0045	+ .09
241	− .0228	1.0	− .815	− 50	+ .0008	+ .02
261	− .0238	0.9	− .858	− 45	+ .0017	+ .03
415	− .0179	0.7	− .977	− 13	− .0045	− .07
434	− .0227	1.2	− .958	− 4	+ .0004	+ .01
447	− .0201	1.0	− .954	− 3	− .0022	− .04
460	− .0209	1.0	− .951	− 2	− .0014	− .03
1312	− .0150	1.0	+ .888	+191	− .0010	+ .02
1313	− .0147	1.0	+ .888	+191	− .0013	− .03
1328	− .0182	1.0	+ .812	+200	+ .0020	− .04
1344	−0.0176	1.0	+0.646	+215	+0.0009	+0.02

The normal equations are:

$$14.0c + 1.631\mu - 0.9418\pi = - 0.2724 \text{ mm.}$$
$$+ 23.6798\mu + 4.7997\pi = - 0.0106 \text{ mm.}$$
$$+ 9.4839\pi = + 0.0492 \text{ mm.}$$

from which:

$c = - 0.01927$ mm.

$\mu = + 0.00024$ mm. $= + 0''.0050$, or $+ 0''.018$ per year.

$\pi = + 0.00315$ mm. $= + \mathbf{0''.066 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00150 \text{ mm.} = \pm 0''.031.$$

LALANDE 38287 ($19^h\ 58^m$; $+ 15°\ 20'$)

This star 7.19 magnitude and G5 type has a total proper motion 0″.61. Its parallax has been twice determined, Chase with the Yale heliometer finding the value $+ 0''.075 \pm 0''.038$, and Adams and Joy by the spectograph the result $+ 0''.068$. Mr. Oliver measured the McCormick plates.

TABLE 1

PLATES OF LALANDE 38287

No.	Date.	Hour Angle.	Observers.	Weight.
3106	1916 Sept. 27	+0h1	Ol	0.8
3107	Sept. 27	+0.7	Ol	0.9
3140	Oct. 6	+0.4	L	0.8
3141	Oct. 6	+0.9	Ol	0.6
3309	Oct. 30	+0.5	Ol	0.6
3320	Nov. 1	+0.4	Ol	0.9
3944	1917 May 9	−0.8	Ol	0.7
3965	May 14	−0.7	Ol	0.8
4025	May 29	0.0	Ol	1.0
4422	Sept. 12	+0.5	Ol	1.0
4423	Sept. 12	+0.8	Ol	1.0
4500	Oct. 2	+0.2	Ol	0.9
4561	Oct. 12	−0.3	Ol	1.0
4562	Oct. 12	0.0	Ol	0.9
5374	1918 May 16	−1.1	Ol	0.8
5375	May 16	−0.6	Ol	0.9
5386	May 18	−0.7	Ol	0.8
5387	May 18	−0.3	Ol	0.7
5390	May 25	−1.4	Ol	0.8

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−55.4	+10.1	+0.1392
2	.15	−27.8	−10.8	.1451
3	.17	+13.0	− 3.5	.2125
4	.12	+27.9	−23.3	.2027
5	.17	+42.3	+27.5	+0.3005
Parallax star	0.17	+ 9.4	+ 2.6	

TABLE 2

REDUCTIONS FOR LALANDE 38287

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3106	+0.0150	0.8	−0.904	−295	+0.0016	+0″.03
3107	+ .0144	0.9	− .904	−295	+ .0022	+ .04
3140	+ .0170	0.8	− .949	−286	− .0007	− .01
3141	+ .0181	0.6	− .949	−286	− .0018	− .03
3309	+ .0163	0.6	− .959	−262	− .0006	− .01
3320	+ .0173	0.9	− .953	−260	− .0016	− .03
3944	+ .0177	0.7	+ .921	− 71	+ .0010	+ .02
3965	+ .0188	0.8	+ .889	− 66	− .0006	− .01
4025	+ .0186	1.0	+ .753	− 51	− .0010	− .02
4422	+ .0081	1.0	− .778	+ 55	+ .0016	+ .03
4423	+ .0085	1.0	− .778	+ 55	+ .0012	+ .02
4500	+ .0097	0.9	− .930	+ 75	− .0010	− .02
4561	+ .0085	1.0	− .967	+ 85	− .0002	.00
4562	+ .0094	0.9	− .967	+ 85	− .0011	− .02
5374	+ .0111	0.8	+ .876	+301	− .0005	− .01
5375	+ .0105	0.9	+ .876	+301	+ .0001	.00
5386	+ .0110	0.8	+ .860	+303	− .0005	− .01
5387	+ .0094	0.7	+ .860	+303	+ .0011	+ .02
5390	+0.0100	0.8	+0.798	+310	+0.0001	0.00

The normal equations are:

$$15.9c + 1.066\mu - 3.0023\pi = + 0.2048 \text{ mm.}$$
$$+ 76.7553\mu - 18.0847\pi = - 0.0812 \text{ mm.}$$
$$+ 12.5014\pi = + 0.0330 \text{ mm.}$$

from which:

$c = + 0.01373$ mm.

$\mu = - 0.00213$ mm. $= - 0''.0443$, or $- 0''.162$ per year

$\pi = + 0.00374$ mm. $= + \mathbf{0''.078} \pm \mathbf{0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00077 \text{ mm.} = \pm 0''.016.$$

LALANDE 38383 ($19^h\ 59^m$; $+23°\ 5'$)

This is a star of considerable proper motion 1".39 per year, of magnitude 7.2 and spectral type G8. Its parallax has been measured several times with the following results:

Observer.	Method.	Parallax.
Flint	Meridian circle	−0".02 ±0".028
Chase	Heliometer	+ .095± .043
Jewdokimov	Meridian circle	+ .102± .068
Allegheny	Photography	+ .038± .007
Adams	Spectrograph	+0.126

Mr. Alden measured the McCormick series of plates with the exception of the four last, which were measured by Mr. Mitchell. A parallax of + 0".075 ± 0".009 was derived, and a proper

TABLE 1

PLATES OF LALANDE 38383

No.	Date.	Hour Angle.	Observers.	Weight.
3271	1916 Oct. 25	+0h6	Ol	0.8
3279	Oct. 26	+0.6	Ol	1.0
3345	Nov. 5	+0.8	M	1.0
4154	1917 July 1	−0.2	A	0.8
4155	July 1	+0.1	A	0.7
4593	Oct. 17	0.0	M	1.0
4597	Oct. 20	0.0	B	0.9
4598	Oct. 20	+0.4	B	1.0
5410	1918 June 3	+0.1	A	1.0
5411	June 3	+0.6	A	1.0
5458	June 15	+0.3	A	1.0
5459	June 15	+0.8	A	1.0
5460	June 15	+1.2	A	1.0
5683	Sept. 14	+0.2	M	1.0
5684	Sept. 14	+0.6	M	0.9
5758	Oct. 4	+0.3	M, F	1.0
5759	Oct. 4	+0.7	M, H	1.0

motion in right ascension of − 1″.017 per year while the corresponding value from Porter is − 1″.030. Adams has determined the radial velocity of − 2 km. per sec., so that the motion of the star is almost entirely at right angles to the line of sight.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−43.7	−35.5	+0.2230
2	.08	−30.8	+10.1	.1928
3	.10	+ 5.1	+20.1	.1867
4	.10	+17.2	+ 9.5	.1940
5	.08	+52.2	− 4.2	+0.2035
Parallax star	0.12	− 0.8	− 1.2	

TABLE 2

REDUCTIONS FOR LALANDE 38383

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3271	−0.0014	0.8	−0.971	−432	+0.0015	+0″.03
3279	− .0016	1.0	− .970	−431	+ .0015	+ .03
3345	− .0018	1.0	− .937	−421	+ .0005	+ .01
4154	− .0255	0.8	+ .312	−183	− .0032	− .06
4155	− .0246	0.7	+ .312	−183	− .0041	− .07
4593	− .0481	1.0	− .996	− 75	+ .0003	+ .01
4597	− .0462	0.9	− .975	− 72	− .0020	− .04
4598	− .0488	1.0	− .975	− 72	+ .0006	+ .01
5410	− .0742	1.0	+ .704	+154	+ .0018	+ .04
5411	− .0720	1.0	+ .704	+154	− .0004	− .01
5458	− .0759	1.0	+ .552	+166	+ .0014	+ .03
5459	− .0754	1.0	+ .552	+166	+ .0009	+ .02
5460	− .0756	1.0	+ .552	+166	+ .0011	+ .02
5683	− .0890	1.0	− .791	+257	− .0025	− .05
5684	− .0910	0.9	− .791	+257	− .0005	− .01
5758	− .0951	1.0	− .937	+277	+ .0004	+ .01
5759	−0.0957	1.0	−0.937	+277	+0.0010	+0.02

The normal equations are:

$$16.1c + 1.644\mu - 5.3772\pi = -0.9154 \text{ mm.}$$
$$+ 98.7060\mu + 8.5695\pi = -1.3802 \text{ mm.}$$
$$+ 10.3674\pi = +0.2144 \text{ mm.}$$

from which:

$c = -0.05429$ mm.

$\mu = -0.01339$ mm. $= -0''.2785$, or $-1''.017$ per year.

$\pi = +0.00359$ mm. $= +\mathbf{0''.075 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00118 \text{ mm.} = \pm 0''.025.$$

BD + 36°.3883 (20^h 4^m; + 36° 17′)

This star is one of the 248 stars in the region surrounding BD+35°.4013 whose parallaxes were determined by Kapteyn from photographs taken by Donner (see page 11). The star was put on the McCormick program on account of the large parallax determined by Kapteyn amounting to $+0''.18$. Mr. Oliver measured the McCormick plates and found a parallax of $-0''.009 \pm 0''.010$.

TABLE 1.

PLATES OF BD + 36° 3883

No.	Date.	Hour Angle.	Observers.	Weight.
3156	1916 Oct. 8	−0^{h}3	M	1.0
3157	Oct. 8	0.0	L	0.9
3229	Oct. 21	−0.2	M	1.0
3230	Oct. 21	0.0	M	1.0
4142	1917 June 30	−0.5	Ol	0.9
4143	June 30	−0.3	Ol	0.9
4443	Sept. 19	−0.3	M	0.8
4444	Sept. 19	0.0	M	0.8
4532	Oct. 7	−0.4	M	0.9
4533	Oct. 7	−0.1	M	0.9
5392	1918 May 25	−0.6	Ol	1.0
5393	May 25	−0.3	Ol	1.0
5394	May 25	0.0	Ol	0.9
5417	June 4	−0.6	Ol	0.8
5418	June 4	−0.2	Ol	0.7

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−16.3	+52.1	+0.3708
2	.13	−11.2	−34.0	.3657
3	.09	+27.5	−18.1	+0.2635
Parallax star	0.12	− 2.9	+ 2.1	

TABLE 2

REDUCTIONS FOR BD 36°.3883

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3156	−0.0022	1.0	−0.950	−331	−0.0014	−0″.03
3157	− .0034	0.9	− .950	−331	− .0002	.00
3229	− .0025	1.0	− .974	−318	− .0010	− .02
3230	− .0050	1.0	− .974	−318	+ .0014	+ .03
4142	− .0061	0.9	+ .343	− 66	+ .0023	+ .05
4143	− .0032	0.9	+ .343	− 66	− .0006	− .01
4443	− .0031	0.8	− .829	+ 15	.0000	.00
4444	− .0027	0.8	− .829	+ 15	− .0004	− .01
4532	− .0038	0.9	− .945	+ 33	+ .0008	+ .01
4533	− .0033	0.9	− .945	+ 33	+ .0003	+ .01
5392	− .0014	1.0	+ .809	+263	− .0021	− .04
5393	− .0024	1.0	+ .809	+263	− .0011	− .02
5394	− .0052	0.9	+ .809	+263	+ .0017	+ .03
5417	− .0047	0.8	+ .704	+273	+ .0013	+ .02
5418	−0.0025	0.7	+0.704	+273	−0.0009	−0.02

The normal equations are:

$$13.5c - 1.281\mu - 2.7609\pi = -0.0462 \text{ mm.}$$
$$+ 73.2958\mu + 20.0545\pi = +0.0066 \text{ mm.}$$
$$+ 9.1723\pi = +0.0086 \text{ mm.}$$

from which:

$c = -0.00350$ mm.

$\mu = +0.00015$ mm. $= +0''.0032$, or $+0''.012$ per year

$\pi = -0.00046$ mm. $= -\mathbf{0''.009} \pm \mathbf{0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00090 \text{ mm.} = \pm 0''.019.$$

LALANDE 38683 ($20^h\ 6^m$; $+15°\ 53'$)

This star has a total proper motion of 0″.55, and is of spectral type G5 and magnitude 7.3. The Yale heliometer has found a relative parallax of + 0″.067 ± 0″.042, and Adams the absolute parallax of + 0″.076. Miss Hawes measured the McCormick plates and found a relative parallax of + 0″.054 ± 0″.013, and a proper motion in right ascension amounting to − 0″.390 per year.

TABLE 1

PLATES OF LALANDE 38683

No.	Date.	Hour Angle.	Observers.	Weight.
4662	1917 Nov. 1	+0^{h}6	M	0.9
4663	Nov. 1	+0.8	M	1.0
4675	Nov. 2	+0.5	M	1.0
4676	Nov. 2	+0.7	M	1.0
5503	1918 July 2	−0.9	A	0.9
5504	July 2	−0.7	A	0.8
5505	July 2	−0.6	A	0.7
5820	Oct. 21	+0.4	M	0.8
5821	Oct. 21	+0.6	M	0.9
5837	Oct. 22	+0.6	M, D	1.0
5844	Nov. 1	+0.8	M, H	0.7
7045	1919 May 18	−0.8	D	1.0
7046	May 18	−0.6	D	1.0
7070	May 22	−0.5	F	1.0
7071	May 22	−0.2	F	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−59.3	− 1.8	+0.237
2	.11	−12.1	+ 5.1	.228
3	.13	+31.2	−24.8	.347
4	.18	+40.2	+21.5	+0.188
Parallax star	0.15	+ 1.5	− 3.8	

TABLE 2

REDUCTIONS FOR LALANDE 38683

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4662	−0.0327	0.9	−0.957	−294	−0.0007	−0″.01
4663	− .0343	1.0	− .957	−294	+ .0009	+ .02
4675	− .0368	1.0	− .954	−293	+ .0034	+ .07
4676	− .0338	1.0	− .954	−293	+ .0004	+ .01
5503	− .0408	0.9	+ .327	− 51	− .0017	− .03
5504	− .0376	0.8	+ .327	− 51	− .0049	− .09
5505	− .0422	0.7	+ .327	− 51	− .0003	.00
5820	− .0524	0.8	− .972	+ 60	+ .0008	+ .01
5821	− .0510	0.9	− .972	+ 60	− .0006	− .01
5837	− .0502	1.0	− .972	+ 61	− .0015	− .03
5844	− .0506	0.7	− .958	+ 71	− .0015	− .03
7045	− .0592	1.0	+ .876	+269	+ .0017	+ .04
7046	− .0580	1.0	+ .876	+269	+ .0005	+ .01
7070	− .0584	1.0	+ .844	+273	+ .0006	+ .01
7071	−0.0590	1.0	+0.844	+273	+0.0012	+0.02

The normal equations are:

$$13.7c + 0.297\mu - 2.7965\pi = - 0.6387 \text{ mm.}$$
$$+ 64.9318\mu + 17.7966\pi = - 0.3009 \text{ mm.}$$
$$+ 9.9697\pi = + 0.0632 \text{ mm.}$$

from which:

$c = - 0.04598$ mm.

$\mu = - 0.00514$ mm. $= - 0''.1069$, $= - 0''.390$ per year.

$\pi = + 0.00262$ mm. $= +$ **0″.054 ± 0″.013.**

Probable error of plate of unit weight

$$\pm 0.00061 \text{ mm.} = \pm 0''.013.$$

o^1 CYGNI ($20^h\ 10^m$; $+46°\ 30'$)

Allegheny Observatory finds the parallax $-0''.011 \pm 0''.010$ for this star 30 Cygni which is of magnitude 4.96 and of A2 type, and of very small proper motion. Mr. Alden measured the parallaxes of o^1 and o^2 Cygni from the same series of plates. For o^1 Cygni, the annual proper motion in right ascension from the plates was found to be $-0''.020$, while the value from Boss is $+0''.015$.

TABLE 1

PLATES OF o^1 AND o^2 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
348	1914 Sept. 29	$-0^h.1$	M, A	1.0
366	Oct. 1	−0.2	M, Ol	0.9
408	Oct. 19	−0.3	M, Ol	0.6*
414	Oct. 21	−0.1	M, Ol	0.7*
1409	1915 June 28	−0.9	G	1.0
1410	June 28	−0.5	G	0.8
1440	July 8	0.0	G	0.8
1450	July 9	0.0	G	0.8
1602	Sept. 1	−0.7	Ol	0.9
1603	Sept. 1	−0.3	Ol	0.7*
1631	Sept. 9	−0.7	Ol	0.9
1632	Sept. 9	−0.3	Ol	0.7
1773	Oct. 3	−1.0	M	0.8
1774	Oct. 3	−0.7	M	0.8
2706	1916 June 3	−1.2	M	0.8
2707	June 3	−0.9	M	0.8
2708	June 3	−0.5	M	0.9
3064	Sept. 23	−0.3	A	0.9
3065	Sept. 23	0.0	A	0.9
3142	Oct. 7	−0.1	A	0.9
3143	Oct. 7	+0.1	A	0.6*

* One exposure.

o^2 CYGNI ($20^h\ 10^m$; $+46°\ 26'$)

Adams by means of the spectrograph has found the absolute parallax of this star, 31 Cygni to be + 0″.016, while Allegheny finds the relative parallax − 0″.013 ± 0″.009. The star is of Kop type, of magnitude 3.95, and of very small annual proper motion, 0″.002. The proper motion in right ascension from the plates is + 0″.001 while the value from Boss is + 0″.002. Campbell (*Lick Observatory Bulletin*, **1**, 22, 1901) has found the star to be a spectroscopic binary.

COMPARISON STARS FOR o^1 CYGNI

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−29.7	+39.6	+0.224
2	.13	−24.0	−34.3	.162
3	.12	+ 9.0	+13.5	.215
4	.12	+10.9	−15.5	.190
5	.11	+33.8	− 3.3	+0.209
o^1 Cygni	0.12	+ 0.6	+ 2.6	

COMPARISON STARS FOR o^2 CYGNI

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
2	0.13	−31.5	−24.4	+0.242
3	.12	+ 1.6	+23.4	.099
4	.12	+ 3.5	− 5.6	.308
5	.11	+26.4	+ 6.6	+0.351
o^2 Cygni	0.17	+ 2.9	− 0.5	

TABLE 2

REDUCTIONS FOR o^1 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
348	+0.0254	1.0	−0.890	−382	−0.0004	−0″.01
366	+ .0258	0.9	− .902	−380	− .0008	− .02
408	+ .0242	0.6	− .969	−362	+ .0006	+ .01
414	+ .0208	0.7	− .971	−360	+ .0040	+ .07
1409	+ .0254	1.0	+ .406	−110	+ .0002	.00
1410	+ .0262	0.8	+ .406	−110	− .0006	− .01
1440	+ .0291	0.8	+ .295	−100	− .0036	− .07
1450	+ .0240	0.8	+ .234	− 99	+ .0014	+ .03
1602	+ .0257	0.9	− .670	− 40	− .0014	− .03
1603	+ .0237	0.7	− .670	− 40	+ .0006	+ .01
1631	+ .0238	0.9	− .704	− 37	+ .0004	+ .01
1632	+ .0211	0.7	− .704	− 37	+ .0031	+ .05
1773	+ .0265	0.8	− .913	− 13	− .0026	− .05
1774	+ .0260	0.8	− .913	− 13	− .0020	− .04
2706	+ .0228	0.8	+ .727	+231	+ .0022	+ .04
2707	+ .0256	0.8	+ .727	+231	− .0006	− .01
2708	+ .0248	0.9	+ .727	+231	+ .0002	.00
3064	+ .0258	0.9	− .849	+343	− .0028	− .05
3065	+ .0217	0.9	− .849	+343	+ .0014	+ .03
3142	+ .0223	0.9	− .937	+357	+ .0006	+ .01
3143	+0.0210	0.6	−0.937	+357	+0.0019	+0.03

The normal equations are:

$$17.2c + 0.360\mu - 6.5843\pi = + 0.4209 \text{ mm.}$$
$$+ 102.4216\mu + 4.7856\pi = - 0.0140 \text{ mm.}$$
$$+ 9.9385\pi = - 0.1545 \text{ mm.}$$

from which:

$c = + 0.02489$ mm.

$\mu = - 0.00027$ mm. $= - 0''.0057$, or $- 0''.020$ per year.

$\pi = + 0.00107$ mm. $= + \mathbf{0''.022 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

TABLE 3

REDUCTIONS FOR o^2 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
348	+0.0261	1.0	−0.890	−382	−0.0016	−0″.03
366	+ .0272	0.9	− .902	−380	− .0027	− .05
408	+ .0210	0.6	− .969	−362	+ .0035	+ .06
414	+ .0213	0.7	− .971	−360	+ .0032	+ .06
1409	+ .0234	1.0	+ .406	−110	+ .0012	+ .02
1410	+ .0290	0.8	+ .406	−110	− .0044	− .08
1440	+ .0246	0.8	+ .295	−100	.0000	.00
1450	+ .0234	0.8	+ .234	− 99	+ .0012	+ .02
1602	+ .0262	0.9	− .670	− 40	− .0014	− .03
1603	+ .0184	0.7	− .670	− 40	+ .0064	+ .11
1631	+ .0269	0.9	− .704	− 37	− .0021	− .04
1632	+ .0216	0.7	− .704	− 37	+ .0032	+ .05
1773	+ .0253	0.8	− .913	− 13	− .0005	− .01
1774	+ .0273	0.8	− .913	− 13	− .0025	− .05
2706	+ .0254	0.8	+ .727	+231	− .0006	− .01
2707	+ .0229	0.8	+ .727	+231	+ .0020	+ .04
2708	+ .0251	0.9	+ .727	+231	− .0002	.00
3064	+ .0280	0.9	− .849	+343	− .0029	− .06
3065	+ .0224	0.9	− .849	+343	+ .0027	+ .05
3142	+ .0253	0.9	− .937	+357	− .0002	.00
3143	+0.0260	0.6	−0.937	+357	−0.0009	−0.01

The normal equations are:

$$17.2c + 0.360\mu - 6.5843\pi = + 0.4259 \text{ mm.}$$
$$+ 102.4216\mu + 4.7856\pi = + 0.0179 \text{ mm.}$$
$$+ 9.9385\pi = - 0.1634 \text{ mm.}$$

from which:

$c = + 0.02472$ mm.

$\mu = + 0.00009$ mm. $= + 0''.0002$, or $+ 0''.001$ per year.

$\pi = - 0.00011$ mm. $= \mathbf{- 0''.002 \pm 0''.013.}$

Probable error of plate of unit weight

$$\pm 0.00164 \text{ mm.} = \pm 0''.034.$$

α^1 CAPRICORNI ($20^h\ 12^m$; $-12°\ 49'$)

The spectroscopic parallax $+\ 0''.003$ has been found for this star which is of G type, of magnitude 4.55, and of small proper motion $0''.04$ per year in position angle 72°. Mr. Olivier measured the parallaxes of α^1 and α^2 Capricorni from the same series of plates. For α^1 Capricorni, he determined the annual proper motion in right ascension to be $+\ 0''.025$ while the value from Boss is $+\ 0''.015$.

TABLE 1

PLATES OF α^1 AND α^2 CAPRICORNI

No.	Date.	Hour Angle.	Observers.	Weight.
350	1914 Sept. 29	$+1^h.4$	M, A	0.9
422	Oct. 23	+0.8	M, Ol	0.8
525	Nov. 9	+0.6	M, Ol	0.8
1459	1915 July 13	+0.2	A	1.0
1460	July 13	+0.7	A	1.0
1482	July 17	−0.3	A, Ol	0.6
1483	July 17	+0.3	Ol	0.8
1656	Sept. 11	+1.0	A	0.8
1657	Sept. 11	+1.6	A	0.8
1733	Sept. 22	+0.1	A	1.0
1767	Oct. 2	−0.1	M	0.9
1768	Oct. 2	+0.4	A	1.0
2708	1916 June 3	−0.2	M	0.6
2709	June 3	+0.2	M	0.6
2731	June 18	−0.6	Ol	0.6
2819	July 12	+0.6	Ol	0.9

COMPARISON STARS, α^1 CAPRICORNI

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.06	−17.5	+39.3	+0.2507
2	.06	−19.0	− 1.1	.2636
3	.08	−16.6	−15.6	.2663
4	.11	+53.1	−22.6	+0.2194
α^1 Capricorni	0.15	− 2.2	+ 0.5	

TABLE 2

REDUCTIONS FOR α^1 CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
350	−0.0114	0.9	−0.885	−343	−0.0001	0″.00
422	− .0109	0.8	− .970	−319	− .0005	− .01
525	− .0132	0.8	− .931	−312	+ .0018	+ .03
1459	− .0120	1.0	+ .179	− 56	+ .0005	+ .01
1460	− .0102	1.0	+ .179	− 56	− .0012	− .02
1482	− .0141	0.6	+ .114	− 52	+ .0027	+ .04
1483	− .0093	0.8	+ .114	− 52	− .0021	− .04
1656	− .0112	0.6	− .720	+ 4	+ .0007	+ .01
1657	− .0081	0.8	− .720	+ 4	− .0024	− .04
1733	− .0098	1.0	− .829	+ 15	− .0006	− .01
1767	− .0108	0.9	− .903	+ 25	+ .0005	+ .01
1768	− .0112	1.0	− .903	+ 25	+ .0009	+ .02
2708	− .0103	0.6	+ .723	+270	− .0005	− .01
2709	− .0122	0.6	+ .733	+270	+ .0014	+ .02
2731	− .0106	0.6	+ .547	+285	.0000	.00
2819	−0.0109	0.9	+0.505	+288	+0.0003	+0.01

The normal equations are:

$$12.9c - 1.760\mu - 3.6901\pi = -0.1412 \text{ mm.}$$
$$+ 48.7525\mu + 11.2734\pi = +0.0266 \text{ mm.}$$
$$+ 6.2494\pi = +0.0398 \text{ mm.}$$

from which:

$c = -0.01113$ mm.

$\mu = +0.00033$ mm. $= +0''.0068$, or $+0''.025$ per year.

$\pi = -0.00080$ mm. $= -$ **0″.017 ± 0″.009.**

Probable error of plate of unit weight

$$\pm 0.00076 \text{ mm.} = \pm 0''.016.$$

α^2 CAPRICORNI ($20^h\ 12^m$; $-12°\ 51'$)

Adams and Joy find the parallax for this star $+0''.024$. It is of Ko type, of magnitude 3.77, and of small proper motion $0''.014$ per year in position angle 328°. This is a triple star, B

and C are separated by 1″, and are of twelfth and thirteenth magnitudes respectively. BC is distant 7″ from A. The annual proper motion from the plates is + 0″.032 in right ascension while the value from Boss is + 0″.058.

COMPARISON STARS, α^2 CAPRICORNI

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.06	−35.5	+39.4	+0.1046
2	.06	−37.0	− 1.0	.2334
3	.08	−34.6	−15.5	.2772
4	.11	+35.1	−22.5	.2425
5	.14	+72.0	− 0.4	+0.1423
α^2 Capricorni	0.18	− 3.2	− 5.9	

TABLE 3

REDUCTIONS FOR α^2 CAPRICORNI

Plate.	Solution (*m*).	Weight (*p*.)	Parallax Factor (*P*).	Time in Days (*t*).	Residual (*v*).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
350	+0.0170	0.9	−0.885	−327	−0.0023	−0″.04
422	+ .0150	0.7	− .970	−305	− .0001	.00
525	+ .0154	0.8	− .931	−296	− .0005	− .01
1459	+ .0135	1.0	+ .179	− 40	+ .0016	+ .03
1460	+ .0140	1.0	+ .179	− 40	+ .0011	+ .02
1482	+ .0146	0.6	+ .114	− 36	+ .0005	+ .01
1656	+ .0160	0.9	− .720	+ 20	.0000	.00
1657	+ .0142	0.8	− .720	+ 20	+ .0018	+ .03
1733	+ .0169	1.0	− .829	+ 31	− .0007	− .01
1767	+ .0167	0.9	− .903	+ 41	− .0004	− .01
1768	+ .0146	1.0	− .903	+ 41	+ .0017	+ .03
2708	+ .0150	0.6	+ .733	+286	+ .0010	+ .02
2731	+ .0165	0.6	+ .547	+301	− .0003	.00
2819	+0.0195	0.9	+0.505	+304	−0.0032	−0.06

The normal equations are:

$$11.7c - 0.775\mu - 4.3401\pi = + 0.1831 \text{ mm.}$$
$$+ 42.6872\mu + 9.1345\pi = - 0.0012 \text{ mm.}$$
$$+ 5.9780\pi = - 0.0677 \text{ mm.}$$

from which:

$c = +0.01538$ mm.

$\mu = +0.00042$ mm. $= +0''.008$, or $+0''.032$ per year.

$\pi = -0.00081$ mm. $= -\mathbf{0''.017 \pm 0''.013}$.

Probable error of plate of unit weight

± 0.00101 mm. $= \pm 0''.021$.

β^1 and β^2 CAPRICORNI ($20^h\ 15^m$; $-15°\ 6'$)

The spectroscopic parallax $+0''.032$ has been found for β^1 Capricorni a star of magnitude 3.25, and of type Gp, while β^2 Capri

TABLE 1

PLATES OF β CAPRICORNI

No.	Date.	Hour Angle.	Observers.	Weight.
295	1914 Sept. 22	$+0^h.8$	M	0.6
301	Sept. 23	+0.8	G	0.5*
356	Sept. 30	+1.0	M, G	0.7
409	Oct. 19	+0.6	Ol, M	0.7
1451	1915 July 9	+0.7	G	0.8
1604	Sept. 1	+0.2	Ol	0.6
1694	Sept. 15	−0.7	Ol	0.9
1695	Sept. 15	−0.2	Ol	0.7
1745	Sept. 23	+0.4	G	0.7
2681	1916 May 27	−0.3	M	0.7
2682	May 27	0.0	M	0.5*
2696	June 1	−0.4	M	0.7
2697	June 1	+0.1	M	0.6
3013	Sept. 17	+0.6	M	0.9
3014	Sept. 17	+1.1	M	0.9
3143	Oct. 7	+0.6	A	1.0
3166	Oct. 11	+0.3	L	0.9
3167	Oct. 11	+0.7	L	1.0

* One exposure.

corni is of magnitude 6.16 and of type A. Both have very small proper motions which seem to be common to the two stars. β^1 Capricorni is a double, Barnard 12, the companion being 1″ distant. Campbell has found (*Astrophysical Journal*, **10**, 241, 1899) that β^1 Capricorni is a spectroscopic binary, with a period, according to Merrill of 1375 days. Mr. Mitchell measured the parallax of β^1 and β^2 Capricorni from the same series of plates. The annual proper motions from the plates were − 0″.007 and + 0″.006 respectively, while the values from Boss are + 0″.035 and + 0″.042.

COMPARISON STARS, β^1 CAPRICORNI

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
2	0.11	−28.0	−12.1	+0.373
3	.10	+ 8.1	+47.8	.291
4	.12	+19.9	−35.7	+0.336
β^1 Capricorni	0.10	− 1.4	− 2.6	

COMPARISON STARS, β^2 CAPRICORNI

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−25.8	+ 3.6	+0.280
2	.11	−19.4	−13.3	.291
3	.10	+16.7	+46.6	.172
4	.12	+28.5	−36.9	+0.257
β^2 Capricorni	0.24	− 2.7	− 4.4	

TABLE 2

REDUCTIONS FOR β^1 CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
295	−0.0084	0.6	−0.824	−366	−0.0015	−0″.02
356	− .0128	0.7	− .886	−358	+ .0028	+ .05
409	− .0127	0.7	− .965	−339	+ .0026	+ .04
1451	− .0077	0.8	+ .255	− 76	− .0016	− .03
1604	− .0096	0.6	− .588	− 24	− .0005	− .01
1694	− .0085	0.9	− .754	− 8	− .0017	− .03
1695	− .0099	0.7	− .754	− 8	− .0003	− .01
1745	− .0071	0.7	− .830	0	− .0032	− .05
2681	− .0102	0.7	+ .811	+247	+ .0010	+ .02
2682	− .0089	0.5	+ .811	+247	− .0003	.00
2696	− .0096	0.7	+ .762	+252	+ .0004	+ .01
2697	− .0100	0.6	+ .762	+252	+ .0008	+ .01
3013	− .0110	0.8	− .898	+360	+ .0003	+ .01
3014	− .0122	0.8	− .898	+360	+ .0015	+ .03
3143	− .0116	1.0	− .973	+380	+ .0008	+ .01
3166	− .0091	0.8	− .946	+384	− .0017	− .03
3167	−0.0114	1.0	−0.946	+384	+0.0006	+0.01

The normal equations are:

$$12.6c + 14.757\mu - 5.8751\pi = - 0.1275 \text{ mm.}$$
$$+ 102.8549\mu - 4.1626\pi = - 0.1554 \text{ mm.}$$
$$+ 8.6520\pi = + 0.0641 \text{ mm.}$$

from which:

$c = - 0.00962$ mm.

$\mu = - 0.00010$ mm. $= - 0''.0020$, or $- 0''.007$ per year.

$\pi = + 0.00084$ mm. $= + \mathbf{0''.002 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00099 \text{ mm.} = \pm 0''.021.$$

TABLE 3

REDUCTIONS FOR β^2 CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
295	+0.0018	0.7	−0.824	−366	−0.0006	−0″.01
301	+ .0011	0.5	− .832	−365	+ .0001	.00
356	− .0004	0.7	− .886	−358	+ .0016	+ .03
409	− .0007	0.7	− .965	−339	+ .0019	+ .03
1451	+ .0043	0.8	+ .255	− 76	− .0028	− .05
1604	+ .0059	0.6	− .588	− 24	− .0044	− .08
1694	+ .0014	1.0	− .754	− 8	+ .0001	.00
1695	− .0004	0.7	− .754	− 8	+ .0019	+ .03
1745	+ .0027	0.7	− .830	0	− .0012	− .02
2681	− .0010	0.7	+ .811	+247	+ .0027	+ .05
2682	− .0018	0.5	+ .811	+247	+ .0035	+ .05
2696	+ .0027	0.7	+ .762	+252	− .0010	− .02
2697	+ .0033	0.6	+ .762	+252	− .0016	− .02
3013	+ .0037	1.0	− .898	+360	− .0019	− .04
3014	+ .0008	1.0	− .898	+360	+ .0010	+ .02
3143	+ .0012	1.0	− .973	+380	+ .0006	+ .01
3166	+ .0029	1.0	− .946	+384	− .0011	− .02
3167	+0.0004	1.0	−0.946	+384	+0.0014	+0.03

The normal equations are:

$$13.9c + 14.766\mu - 6.9973\pi = + 0.0223 \text{ mm.}$$
$$+ 118.9894\mu - 4.3562\pi = + 0.0317 \text{ mm.}$$
$$+ 9.6244\pi = - 0.0111 \text{ mm.}$$

from which:

$c = + 0.00151$ mm.

$\mu = + 0.00008$ mm. $= + 0''.0016$, or $+ 0''.006$ per year.

$\pi = - 0.00001$ mm. $= \mathbf{0''.000 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

γ CYGNI ($20^h\ 18^m$; $+39°\ 56'$)

The McCormick parallax differs very materially from the average of the visual results for this star which is of 2.32 magnitude, of type F8p, and of small annual proper motion, 0″.003. The values of the parallax are:

Authority.	Method.	Parallax.
Pritchard	Photography	+0″.102±0″.021
Chase	Heliometer	+ .099± .038
Flint	Meridian circle	+ .003± .024
Allegheny	Photography	− .022± .008
Adams	Spectrograph	+0.010

The McCormick value of the relative parallax is − 0″.003 ± 0″.010. The last sixteen plates of the series were measured by Miss Hawes, the earlier plates by Mr. Alden. From the plates, the proper motion in right ascension was found to be + 0″.004 while the corresponding value from Boss is + 0″.001.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−52.1	+43.4	+0.1621
2	.14	−46.0	− 9.1	.1890
3	.10	−14.4	−24.7	.1859
4	.11	+20.4	+33.5	.1403
5	.13	+35.9	−19.2	.1639
6	.14	+56.2	−23.8	+0.1588
Parallax star	0.17	− 2.2	− 1.5	

TABLE 2

REDUCTIONS FOR γ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1613	−0.0172	1.0	−0.653	−597	−0.0032	−0″.07
1614	− .0188	1.0	− .653	−597	− .0016	− .03
1784	− .0182	0.7	− .926	−566	− .0021	− .04
1801	− .0240	0.8	− .935	−564	+ .0037	+ .07
1802	− .0258	0.8	− .935	−564	+ .0055	+ .10
2685	− .0210	1.0	+ .789	−331	+ .0006	+ .01
2686	− .0238	1.0	+ .789	−331	+ .0034	+ .07
2689	− .0185	0.6	+ .779	−330	− .0019	− .03
2979	− .0198	0.8	− .686	−229	− .0004	− .01
2980	− .0166	0.8	− .686	−229	− .0036	− .07
3240	− .0170	0.8	− .967	−186	− .0031	− .06
3241	− .0264	0.8	− .967	−186	+ .0063	+ .12
3281	− .0174	1.0	− .967	−181	− .0027	− .06
4050	− .0220	0.9	+ .695	+ 43	+ .0018	+ .04
4051	− .0194	0.9	+ .695	+ 43	− .0008	− .02
4105	− .0182	0.9	+ .515	+ 57	− .0020	− .04
4457	− .0205	1.0	− .800	+147	+ .0006	+ .01
4458	− .0203	1.0	− .800	+147	+ .0004	+ .01
4515	− .0181	1.0	− .907	+161	− .0018	− .04
4516	− .0192	0.7	− .907	+161	− .0007	− .01
5447	− .0220	1.0	+ .686	+409	+ .0020	+ .04
5448	− .0221	0.7	+ .686	+409	+ .0021	+ .04
5494	− .0146	0.8	+ .387	+431	− .0054	− .10
5495	− .0178	1.0	+ .387	+431	− .0022	− .05
5506	− .0206	1.0	+ .372	+432	+ .0006	+ .01
5507	− .0206	0.9	+ .372	+432	+ .0006	+ .01
5723	− .0188	0.8	− .858	+519	− .0009	− .02
5790	− .0222	0.8	− .944	+534	+ .0025	+ .05
5791	−0.0226	0.8	−0.944	+534	+0.0029	+0.05

* One exposure. † Three exposures.

The normal equations are:

$$25.3c + 0.603\mu - 6.0712\pi = -0.5087 \text{ mm.}$$
$$+ 364.1110\mu + 15.4442\pi = +0.0044 \text{ mm.}$$
$$+ 14.7791\pi = +0.1209 \text{ mm.}$$

TABLE 1

PLATES OF γ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight
1613	1915 Sept. 7	−1h1	A	1.0
1614	Sept. 7	−0.6	A	1.0
1784	Oct. 8	−0.5	Ol, G	0.7
1801	Oct. 10	−0.7	M	0.8
1802	Oct. 10	−0.4	M	0.8
2685	1916 May 30	−1.0	M	1.0
2686	May 30	−0.2	M	1.0†
2689	May 31	−1.3	Ol	0.6
2979	Sept. 9	−0.7	A	0.8
2980	Sept. 9	−0.4	A	0.8
3240	Oct. 22	−0.3	M	0.8
3241	Oct. 22	0.0	M	0.8
3281	Oct. 27	−0.2	M	1.0
4050	1917 June 8	−0.6	A	0.9
4051	June 8	−0.3	A	0.9
4105	June 22	−0.2	A	0.9
4457	Sept. 20	−0.7	A	1.0
4458	Sept. 20	−0.4	A	1.0
4515	Oct. 4	−0.3	M	1.0
4516	Oct. 4	0.0	M	0.7*
5447	1918 June 9	−0.3	A	1.0
5448	June 9	0.0	A	0.7*
5494	July 1	−0.7	A	0.8
5495	July 1	−0.4	A	1.0
5506	July 2	−0.4	A	1.0
5507	July 2	−0.1	A	0.9
5723	Sept. 27	−0.2	M	0.8
5790	Oct. 12	−0.6	M	0.8
5791	Oct. 12	−0.2	M	0.8

from which:

$c = -0.02014$ mm.

$\mu = +0.00005$ mm. $= +0''.0011$, or $+0''.004$ per year.

$\pi = -0.00015$ mm. $= \mathbf{-0''.003 \pm 0''.010}$.

Probable error of plate of unit weight

± 0.00177 mm. $= \pm 0''.037$.

ρ CAPRICORNI ($20^h\ 23^m$; $-18°\ 8'$)

The spectroscopic parallax + 0″.011 has been found for this star of magnitude 4.96, of type F, and of small proper motion

TABLE 1

PLATES OF ρ CAPRICORNI

No.	Date.	Hour Angle.	Observers.	Weight.
1762	1915 Sept. 25	$-0^h.2$	A	1.0
1763	Sept. 25	−0.2	A	1.0
1777	Oct. 3	+0.2	M	0.8
1778	Oct. 3	+0.7	M	1.0
4081	1917 June 17	−0.6	Ol	0.5
4082	June 17	−0.1	Ol	0.7
4445	Sept. 19	+0.3	M	0.7*
4687	Nov. 3	+0.4	M	0.9
4688	Nov. 3	+0.8	M	0.9
4695	Nov. 4	+0.5	M	0.9
5449	1918 June 9	+0.5	A	1.0
5508	July 2	+0.3	A	1.0
5509	July 2	+0.6	A	1.0
5696	Sept. 15	+0.2	M	0.8
5697	Sept. 15	+0.7	M	1.0
5717	Sept. 24	+0.1	M	1.0
5718	Sept. 24	+0.5	M	1.0
7096	1919 May 26	−0.7	D	1.0
7097	May 26	−0.2	D	1.0

* One exposure.

0″.026. Mr. Mitchell measured the plates and found a relative parallax of + 0″.019 ± 0″.013, and a proper motion in right ascension + 0″.001 while the corresponding value from Boss is − 0″.014. ρ Capricorni is accompanied by a companion of magnitude 7.6, and at a distance less than 3″. According to Burnham, the two stars form a physical system.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−78.8	+ 7.9	+0.277
2	.13	−21.4	−25.6	.236
3	.08	+45.1	+52.4	.278
4	.11	+55.1	−34.7	+0.209
Parallax star	0.20	− 2.7	+ 3.4	

TABLE 2

REDUCTIONS FOR ρ CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1762	+0.0060	1.0	−0.828	−756	−0.0019	−0″.04
1763	+ .0060	1.0	− .828	−756	− .0019	− .04
1777	+ .0056	0.8	− .888	−748	− .0015	− .03
1778	+ .0016	1.0	− .888	−748	+ .0025	+ .05
4081	+ .0032	0.5	+ .598	−125	+ .0023	+ .03
4082	+ .0037	0.7	+ .598	−125	+ .0018	+ .03
4445	+ .0027	0.7	− .777	− 31	+ .0016	+ .03
4687	+ .0021	0.9	− .956	+ 14	+ .0020	+ .04
4688	+ .0066	0.9	− .956	+ 14	− .0025	− .05
4695	+ .0022	0.9	− .954	+ 15	+ .0019	+ .04
5449	+ .0080	1.0	− .699	+232	− .0024	− .05
5508	+ .0016	1.0	+ .390	+255	+ .0037	+ .08
5509	+ .0045	1.0	+ .390	+255	+ .0008	+ .02
5696	+ .0064	0.8	− .734	+330	− .0020	− .04
5697	+ .0009	1.0	− .734	+330	+ .0034	+ .07
5717	+ .0031	1.0	− .822	+339	+ .0012	+ .02
5718	+ .0084	1.0	− .822	+339	− .0041	− .09
7096	+ .0078	1.0	+ .842	+583	− .0020	− .04
7097	+0.0069	1.0	+0.842	+583	−0.0011	−0.02

The normal equations are:

$$17.2c + 1.886\mu - 5.4623\pi = + 0.0803 \text{ mm.}$$
$$+ 345.9671\mu + 26.8726\pi = + 0.0380 \text{ mm.}$$
$$+ 10.6383\pi = - 0.0172 \text{ mm.}$$

from which:

$c = + 0.00495$ mm.
$\mu = + 0.00001$ mm. $= + 0''.0003$, or $+ 0''.001$ per year.
$\pi = + 0.00089$ mm. $= +$ **0''.019** $\pm$ **0''.013.**

Probable error of plate of unit weight

$$\pm 0.00163 \text{ mm.} = \pm 0''.034.$$

BOSS 5247 (20^h 23^m; $-18°$ 12′)

This star is of magnitude 7.1; and of proper motion 0''.136. Its parallax was determined from the same plates as that of ρ Capricorni, the measures having been made by Mr. Mitchell. A relative parallax $+ 0''.011 \pm 0''.010$ resulted, and a proper motion in right ascension $+ 0''.057$ while the corresponding value from Boss is $+ 0''.040$. No other parallax has been published.

COMPARISON STARS FOR BOSS 5247

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−78.8	+ 7.9	+0.213
2	.13	−21.4	−25.6	.281
3	.08	+45.1	+52.4	.187
4	.11	+55.1	−34.7	+0.319
Parallax star	0.08	+ 3.3	− 6.8	

The normal equations are:

$$15.3c + 3.603\mu - 5.6360\pi = + 0.9629 \text{ mm.}$$
$$+ 344.0248\mu + 27.6010\pi = + 0.5005 \text{ mm.}$$
$$+ 9.7866\pi = - 0.3289 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR BOSS 5247

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1762	+0.0580	1.0	−0.828	−756	−0.0012	−0″.02
1763	+ .0554	1.0	− .828	−756	+ .0014	+ .03
1777	+ .0592	0.8	− .888	−748	− .0024	− .04
1778	+ .0566	1.0	− .888	−748	+ .0002	.00
4687	+ .0622	0.9	− .956	+ 14	+ .0004	+ .01
4688	+ .0620	0.9	− .956	+ 14	+ .0006	+ .01
4695	+ .0604	0.9	− .954	+ 15	+ .0022	+ .04
5449	+ .0634	1.0	+ .699	+232	+ .0017	+ .04
5508	+ .0647	1.0	+ .390	+255	+ .0004	+ .01
5509	+ .0652	1.0	+ .390	+255	− .0001	.00
5696	+ .0659	0.8	− .734	+330	− .0008	− .02
5697	+ .0626	1.0	− .734	+330	+ .0025	+ .05
5717	+ .0654	1.0	− .822	+339	− .0003	− .01
5718	+ .0682	1.0	− .822	+339	− .0031	− .06
7096	+ .0692	1.0	+ .842	+583	− .0014	− .03
7097	+0.0680	1.0	+0.842	+583	−0.0002	0.00

from which:

$c = + 0.06295$ mm.

$\mu = + 0.00075$ mm. $= + 0''.0157$, or $\pm 0''.057$ per year.

$\pi = + 0.00052$ mm. $= + \mathbf{0''.011 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00109 \text{ mm.} = \pm 0''.023.$$

41 CYGNI ($20^h\ 25^m$; $+30°\ 2'$)

This star of magnitude 4.09 and of type F5 has a small proper motion 0″.010. Miss Darkow measured the plates and found a relative parallax $- 0''.023 \pm 0''.006$, with a proper motion in right ascension $+ 0''.016$ where the corresponding value from Boss is $+ 0''.009$. The spectroscopic parallax of Adams and Joy is 0″.009.

TABLE 1

PLATES OF 41 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
1641	1915 Sept. 10	−1ʰ2	A	1.0
1775	Oct. 3	−0.5	M	1.0
1776	Oct. 3	−0.2	M	1.0
3112	1916 Sept. 29	−0.3	L	0.5*
5529	1918 July 6	−0.6	A	0.8
5530	July 6	−0.2	A	0.9
5553	July 14	+0.1	A	0.9
5792	Oct. 12	0.0	M	0.9
5806	Oct. 15	−0.2	M, D	0.9
5835	Oct. 22	−0.3	M	0.8
5836	Oct. 22	0.0	M	0.9
6987	1919 May 7	−1.2	D	1.0
6999	May 12	−1.0	H	1.0
7000	May 12	−0.7	H	0.4*
7034	May 17	−0.8	M	1.0
7643	Sept. 6	−0.4	H	1.0
7644	Sept. 6	−0.1	H	1.0
7748	Sept. 17	−0.7	H	0.9
7749	Sept. 17	−0.3	H	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−33.9	−18.9	+0.230
2	.16	−13.8	+11.2	.266
3	.12	−15.6	−27.5	.161
4	.21	+16.2	+36.2	.262
5	.10	+47.1	− 1.0	+0.081
Parallax star	0.16	− 5.9	+ 3.6	

TABLE 2

REDUCTIONS FOR 41 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot a$. in Arc
	mm.				mm.	
1641	+0.0114	1.0	−0.667	−923	+0.0001	0″.00
1775	+ .0126	1.0	− .884	−900	− .0008	− .02
1776	+ .0110	1.0	− .884	−900	+ .0008	+ .02
3112	+ .0118	0.5	− .861	−538	+ .0007	+ .01
5529	+ .0126	0.8	+ .336	+107	.0000	.00
5530	+ .0146	0.9	+ .336	+107	− .0020	− .04
5553	+ .0109	0.9	+ .210	+115	+ .0018	+ .04
5792	+ .0143	0.9	− .935	+205	− .0001	.00
5806	+ .0150	0.9	− .946	+208	− .0008	− .01
5835	+ .0144	0.8	− .962	+215	− .0002	.00
5836	+ .0148	0.9	− .962	+215	− .0006	− .01
6987	+ .0124	1.0	+ .957	+412	+ .0002	.00
6999	+ .0124	1.0	+ .937	+417	+ .0002	.00
7000	+ .0172	0.4	+ .937	+417	− .0046	− .06
7034	+ .0111	1.0	+ .910	+422	+ .0016	+ .03
7643	+ .0150	1.0	− .619	+534	− .0004	− .01
7644	+ .0140	1.0	− .619	+534	+ .0006	+ .01
7748	+ .0132	0.9	− .746	+545	+ .0015	+ .03
7749	+0.0152	0.9	−0.746	+545	−0.0005	−0.01

The normal equations are:

$$16.8c + 14.974\mu - 4.8356\pi = + 0.2225 \text{ mm.}$$
$$+ 449.9589\mu + 17.5250\pi = + 0.2671 \text{ mm.}$$
$$+ 10.5167\pi = - 0.0694 \text{ mm.}$$

from which:

$c = + 0.01274$ mm.

$\mu = + 0.00021$ mm. $= + 0''.0044$, or $+ 0''.016$ per year.

$\pi = - 0.00109$ mm. $= - \mathbf{0''.023 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00080 \text{ mm.} = \pm 0''.017.$$

β DELPHINI ($20^h\ 32^m$; $+14°\ 14'$)

This is a double, β 151, discovered by Burnham in 1873 with the six-inch telescope when separated by a distance of only $0''.7$, the principal star of magnitude 4.0, and the companion of magnitude 5.0. The principal star is of type F5. The parallax has been four times determined with the following results: Flint with the meridian circle obtaining the value $-0''.02$

TABLE 1

PLATES OF β DELPHINI

No.	Date.	Hour Angle.	Observers.	Weight.
195	1914 Sept. 2	$+0^h.6$	Ol	0.4*
213	Sept. 7	+0.6	M	0.7
214	Sept. 7	+1.2	M	0.8
218	Sept. 9	+0.6	M	0.8
219	Sept. 9	+1.1	M	0.9
242	Sept. 14	+1.2	M, A	0.8
243	Sept. 14	+1.7	M, A	0.9
538	Nov. 10	+0.5	M	0.9
563	Nov. 12	+0.6	Ol	0.8
1346	1915 June 6	+0.1	A	0.5*
1353	June 9	−1.0	Ol	0.8
1354	June 9	−0.6	Ol	0.7
1394	June 25	+0.1	A	0.7
1395	June 25	+0.5	A	0.9
1675	Sept. 13	−0.7	Ol	0.8
1696	Sept. 15	+0.2	Ol	0.6*
1697	Sept. 15	+0.6	Ol	0.7*
3282	1916 Oct. 27	+0.1	M	0.8
3283	Oct. 27	+0.4	M	0.9
3299	Oct. 28	+0.2	Ol	0.9
3339	Nov. 3	−0.1	Ol	0.9
3340	Nov. 3	+0.4	Ol	0.7*
3417	Nov. 21	+0.9	M	1.0

* One exposure.

$\pm$ 0″.027; Swarthmore by photography, + 0″.016 $\pm$ 0″.011; Yerkes by photography, + 0″.043 $\pm$ 0″.006; and Adams by the spectrograph, the absolute parallax of + 0″.032. Several orbits have been published, the most reliable seeming to be the one of Aitken (*Publications Lick Observatory*, **12**, 150, 1914), where the period is 26.79 years, and a = 0″.48. Mr. Olivier measured the McCormick plates, and derived the relative parallax of + 0″.008 $\pm$ 0″.008. The annual proper motion in right ascension from

TABLE 2

REDUCTIONS FOR β DELPHINI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
195	−0.0204	0.4	−0.543	−326	+0.0007	+0″.01
213	− .0206	0.7	− .609	−321	− .0009	− .02
214	− .0206	0.8	− .609	−321	− .0009	− .02
218	− .0206	0.8	− .634	−319	− .0010	− .02
219	− .0206	0.9	− .634	−319	− .0010	− .02
242	− .0224	0.8	− .694	−314	+ .0008	+ .02
243	− .0205	0.9	− .694	−314	− .0010	− .02
538	− .0228	0.9	− .939	−257	+ .0020	+ .04
563	− .0217	0.8	− .931	−255	+ .0010	+ .02
1346	− .0194	0.5	+ .759	− 49	+ .0026	+ .04
1353	− .0170	0.8	+ .727	− 46	+ .0002	.00
1354	− .0149	0.7	+ .727	− 46	− .0019	− .03
1394	− .0170	0.7	+ .528	− 30	+ .0004	+ .01
1395	− .0168	0.9	+ .528	− 30	+ .0002	.00
1675	− .0143	0.8	− .682	+ 50	− .0016	− .03
1696	− .0196	0.6	− .682	+ 52	+ .0038	+ .06
1697	− .0155	0.7	− .682	+ 52	− .0003	− .01
3282	− .0075	0.8	− .962	+460	− .0021	− .04
3283	− .0113	0.9	− .962	+460	+ .0017	+ .03
3299	− .0097	0.9	− .962	+461	+ .0001	.00
3339	− .0105	0.9	− .957	+467	+ .0010	+ .02
3340	− .0085	0.7	− .957	+467	− .0010	− .02
3417	−0.0082	1.0	−0.879	+485	−0.0010	−0.02

the plates is + 0″.118, while the value from Boss is + 0″.108. If we assume the value of the relative parallax to be the mean of the Yerkes, McCormick and Swarthmore values, then the mass of the system is 3.92 times that of the sun.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.27	−41.1	+ 1.3	+0.2768
2	.27	−34.8	+18.4	.2054
3	.21	− 4.2	+27.6	.1131
4	.17	+19.1	− 7.0	.1863
5	.19	+61.0	−40.3	+0.2184
Parallax star	0.22	− 2.1	− 2.9	

The normal equations are:

$$17.9c + 2.719\mu - 9.0070\pi = - 0.2924 \text{ mm.}$$
$$+ 179.5629\mu - 9.7486\pi = + 0.2314 \text{ mm.}$$
$$+ 10.8111\pi = + 0.1366 \text{ mm.}$$

from which:

$c = - 0.01637$ mm.
$\mu = + 0.00156$ mm. $= + 0''.0324$, or $+ 0''.118$ per year.
$\pi = + 0.00040$ mm. $= + 0''.008 \pm 0''.008$.

Probable error of plate of unit weight

$$\pm 0.00089 \text{ mm.} = \pm 0''.018.$$

52 CYGNI ($20^h\ 41^m$; $+30°\ 21'$)

The spectroscopic parallax + 0″.015 has been found for this star which is of 4.34 magnitude, of G5 type, and of small annual proper motion 0″.03. It has a ninth-magnitude companion at a distance of 6″.6, but the pair does not show any relative change. Mr. Lamb measured the McCormick plates with the exception of the three last plates and these were measured by Mr. Mitchell. The annual proper motion in right ascension from the plates is − 0″.028 while the proper motion from Boss is − 0″.016.

TABLE 1

PLATES OF 52 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
1655	1915 Sept. 11	−0h2	A	1.0
1803	Oct. 10	−0.3	M	1.0
1804	Oct. 10	0.0	M	1.0
1815	Oct. 11	−0.2	G	0.8
2755	1916 June 22	−0.7	M	0.5
2772	June 25	−1.2	Ol	0.7
2773	June 25	−0.5	Ol	0.4*
2798	July 5	−0.6	L	0.8
3091	Sept. 26	−1.0	L	0.7
3092	Sept. 26	−0.6	L, M	0.8
3134	Oct. 5	−0.3	L	1.0
3231	Oct. 21	−0.2	M	0.8
3251	Oct. 23	0.0	M	1.0
3931	1917 May 1	−1.8	L	0.8
4001	May 23	−1.1	M	0.6*
4002	May 23	−0.8	M	0.8

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.20	−41.2	+19.4	+0.2574
2	.10	− 5.2	− 9.2	.2005
3	.23	+ 2.4	− 9.7	.1916
4	.10	+ 3.6	−27.4	.1802
5	.16	+40.4	+26.9	+0.1703
Parallax star	0.18	− 3.7	+ 0.9	

TABLE 2

REDUCTIONS FOR 52 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1655	−0.0052	1.0	−0.626	−298	+0.0008	+0″.02
1803	− .0040	1.0	− .897	−269	− .0006	− .01
1804	− .0036	1.0	− .897	−269	− .0010	− .02
1815	− .0025	0.8	− .902	−268	− .0021	− .04
2755	− .0080	0.5	+ .587	− 13	+ .0031	+ .05
2772	− .0046	0.7	+ .547	− 10	− .0003	− .01
2773	− .0050	0.4	+ .547	− 10	+ .0001	.00
2798	− .0065	0.8	+ .405	0	+ .0015	+ .03
3091	− .0064	0.7	− .797	+ 83	+ .0005	+ .01
3092	− .0085	0.8	− .797	+ 83	+ .0026	+ .05
3134	− .0073	1.0	− .870	+ 92	+ .0014	+ .03
3231	− .0052	0.8	− .947	+108	− .0008	− .01
3251	− .0051	1.0	− .951	+110	− .0009	− .02
3931	− .0067	0.8	+ .972	+300	+ .0008	+ .02
4001	− .0042	0.6	+ .891	+322	− .0018	− .03
4002	−0.0035	0.8	+0.891	+322	−0.0025	−0.05

The normal equations are:

$$12.7c + 0.358\mu - 3.6715\pi = -0.0677 \text{ mm.}$$
$$+ 54.8566\mu + 11.2194\pi = -0.0170 \text{ mm.}$$
$$+ 8.4834\pi = +0.0187 \text{ mm.}$$

from which:

$c = -0.00519$ mm.

$\mu = -0.00037$ mm. $= -0''.0077$, or $-0''.028$ per year.

$\pi = +0.00045$ mm. $= +\mathbf{0''.009} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00100 \text{ mm.} = \pm 0''.021.$$

γ DELPHINI ($20^h\ 42^m$; $+15°\ 46'$)

This is a wide pair separated 12″, with a common proper motion of 0″.20, but with little relative change. The magnitudes are 4.49 and 5.47, the brighter being of G5 type. Adams by the spectrograph finds the absolute parallax of + 0″.015 for the brighter star and + 0″.036 for the fainter. Mr. Mitchell measured the McCormick plates. The parallaxes of the pair found were + 0″.038 ± 0″.009, for the brighter star, and + 0″.046 ± 0″.008 for the fainter. Their combined values gives the relative parallax for the system to be:

+ 0″.042 ± 0″.006.

By photography Swarthmore finds the parallaxes of + 0″.007 ± 0″.010 and − 0″.008 ± 0″.015 for brighter and fainter stars.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependences.	
				Brighter.	Fainter.
	mm.	mm.	mm.		
1	0.14	−66.4	+50.3	+0.194	+0.197
2	.25	−14.8	−36.1	.172	.174
3	.22	−14.8	−35.9	.172	.174
4	.25	+44.5	+21.4	.235	.232
5	.14	+51.5	+ 0.3	+0.227	+0.223
Principal star	.20	+ 4.1	+ 2.5		
Companion	0.15	+ 3.6	+ 2.5		

TABLE 1

PLATES OF γ DELPHINI

No.	Date.	Hour Angle.	Observers.	Weight.
70	1914 June 2	$-0^h.4$	M	0.4
71	June 2	0.0	M	0.6
73	June 15	−0.7	M	0.8
74	June 15	−0.3	M	1.0
254	Sept. 15	+0.8	M, G	1.0
262	Sept. 19	+1.0	M, A	1.0
340	Sept. 28	+0.2	M, G	1.0
448	Oct. 31	+0.5	M, A	0.8
461	Nov. 1	+0.2	M	1.0
467	Nov. 2	+0.4	M	0.8
1329	1915 May 22	−1.2	M	0.7
1330	May 22	−0.8	M	0.7
1365	June 10	−0.6	M	0.7
1366	June 10	−0.2	M	0.8
1367	June 10	+0.2	M	0.7
4094	1917 June 18	−0.3	M	1.0
4095	June 18	0.0	M	1.0
4106	June 22	0.0	A	1.0
4107	June 22	+0.3	A	1.0
4459	Sept. 20	−0.4	A	0.7
4460	Sept. 20	+0.4	A	0.7
4534	Oct. 7	−0.4	M	0.8
4535	Oct. 7	−0.1	M	1.0

TABLE 2

REDUCTIONS FOR γ DELPHINI, PRINCIPAL STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
70	−0.0506	0.4	+0.816	−519	−0.0047	−0″.06
71	− .0559	0.6	+ .816	−519	+ .0006	+ .01
73	− .0523	0.8	+ .682	−506	− .0034	− .06
74	− .0528	1.0	+ .682	−506	− .0029	− .06
254	− .0614	1.0	− .675	−414	+ .0018	+ .04
262	− .0624	1.0	− .720	−410	+ .0027	+ .06
340	− .0634	1.0	− .809	−401	+ .0034	+ .07
448	− .0596	0.8	− .958	−368	− .0011	− .02
461	− .0625	1.0	− .958	−367	+ .0018	+ .04
467	− .0584	0.8	− .958	−366	− .0024	− .04
1329	− .0610	0.7	+ .901	−175	+ .0010	+ .02
1330	− .0588	0.7	+ .901	−175	− .0012	− .02
1365	− .0612	0.7	+ .740	−146	+ .0004	+ .01
1366	− .0612	0.8	+ .740	−146	+ .0004	+ .01
1367	− .0606	0.7	+ .740	−146	− .0002	.00
4094	− .0713	1.0	+ .642	+593	− .0002	.00
4095	− .0734	1.0	+ .642	+593	+ .0019	+ .04
4106	− .0746	1.0	+ .592	+597	+ .0030	+ .06
4107	− .0740	1.0	+ .592	+597	+ .0024	+ .05
4459	− .0727	0.7	− .734	+687	− .0027	− .05
4460	− .0716	0.7	− .734	+687	− .0038	− .07
4534	− .0764	0.8	− .880	+704	+ .0005	+ .01
4535	−0.0729	1.0	−0.880	+704	−0.0030	−0.06

The normal equations are:

$$19.2c + 4.338\mu + 0.0946\pi = -1.2389 \text{ mm.}$$
$$+ 463.9467\mu - 0.4276\pi = -0.9418 \text{ mm.}$$
$$+ 11.5324\pi = +0.0159 \text{ mm.}$$

from which:

$c = -0.06421$ mm.

$\mu = -0.00143$ mm. $= -0''.0297$, or $-0''.108$ per year.

$\pi = +0.00185$ mm. $= +\mathbf{0''.038} \pm \mathbf{0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00152 \text{ mm.} = \pm 0''.032.$$

TABLE 3

REDUCTIONS FOR γ DELPHINI, COMPANION

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
70	+0.0274	0.4	+0.816	−519	−0.0010	−0″.01
71	+ .0271	0.6	+ .816	−519	− .0008	− .01
73	+ .0305	0.8	+ .682	−506	− .0046	− .09
74	+ .0242	1.0	+ .682	−506	+ .0017	+ .04
254	+ .0230	1.0	− .675	−414	− .0010	− .02
262	+ .0224	1.0	− .720	−410	− .0006	− .01
340	+ .0181	1.0	− .809	−401	+ .0034	+ .07
448	+ .0206	0.8	− .958	−368	+ .0003	.00
461	+ .0206	1.0	− .958	−367	+ .0002	.00
467	+ .0200	0.8	− .958	−366	+ .0008	+ .02
1329	+ .0241	0.7	+ .901	−175	− .0011	− .02
1330	+ .0244	0.7	+ .901	−175	− .0014	− .02
1365	+ .0231	0.7	+ .740	−146	− .0008	− .01
1366	+ .0207	0.8	+ .740	−146	+ .0016	+ .03
1367	+ .0208	0.7	+ .740	−146	+ .0015	+ .03
4094	+ .0136	1.0	+ .642	+593	+ .0008	+ .02
4095	+ .0129	1.0	+ .642	+593	+ .0016	+ .03
4106	+ .0126	1.0	+ .592	+597	+ .0017	+ .04
4107	+ .0148	1.0	+ .592	+597	− .0005	− .01
4459	+ .0094	0.7	− .734	+687	+ .0010	+ .02
4460	+ .0157	0.7	− .734	+687	− .0053	− .09
4534	+ .0106	0.8	− .880	+704	− .0007	− .01
4535	+0.0101	1.0	−0.880	+704	−0.0002	0.00

The normal equations are:

$$19.2c + 4.338\mu + 0.0946\pi = + 0.3637 \text{ mm.}$$
$$+ 463.9467\mu - 0.4276\pi = - 0.3979 \text{ mm.}$$
$$+ 11.5324\pi = + 0.0278 \text{ mm.}$$

from which:

$c = + 0.01917$ mm.

$\mu = - 0.00103$ mm. $= - 0''.0215$, or $- 0''.078$ per year.

$\pi = + 0.00221$ mm. $= + \mathbf{0''.046 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00124 \text{ mm.} = \pm 0''.026.$$

ϵ CYGNI ($20^h\ 42^m$; $+33°\ 36'$)

This star has considerable proper motion 0″.483 per year, is of spectral type Ko, and of magnitude 2.64. Various discordant values of the parallax have been determined as follows:

Authority.	Method.	Parallax.
Pritchard	Photography	+0″.093±0″.031
Pritchard	Photography	+ .163± .027
Flint$_1$	Meridian circle	− .19 ± .052
Flint$_2$	Meridian circle	− .016± .024
Jewdokimov	Meridian circle	− .055± .071
Allegheny	Photography	+ .054± .005
Adams	Spectrograph	+0.044

Mr. Mitchell measured seventeen of the McCormick plates, Mr. Graham measuring ten of the earlier plates. The McCormick parallax is + 0″.039 ± 0″.008, while the proper motion in right ascension from the plates is + 0″.356, while the corresponding value from Boss is + 0″.360.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.17	−59.9	+30.4	+0.238
2	.10	+ 2.8	−22.3	.278
3	.12	+18.4	−30.1	.281
4	.11	+38.7	+22.0	+0.203
Parallax star	0.15	− 0.3	− 2.9	

TABLE 1

PLATES OF ϵ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
50	1914 May 25	$-0^h.5$	M	0.5
62	May 31	−0.6	M	1.0
63	May 31	−0.2	M	1.0
69	June 2	−0.9	M	0.7
205	Sept. 5	−0.2	M, G	0.7
253	Sept. 15	−0.1	M, G	0.7
281	Sept. 21	−0.6	M	1.0
282	Sept. 21	−0.2	M	0.7
339	Sept. 28	−0.2	M	0.7*
421	Oct. 23	−0.4	Ol	0.7
517	Nov. 6	−0.1	M	1.0
1368	1915 June 17	−0.8	G	0.8
1369	June 17	−0.4	G	1.0
1373	June 18	−1.3	M	0.8
1374	June 18	−0.6	M	0.7*
4609	1917 Oct. 21	−0.6	M	1.0
4610	Oct. 21	−0.2	M	1.0
4621	Oct. 22	−0.5	M	1.0
4622	Oct. 22	−0.2	M	1.0
5424	1918 June 5	−0.3	L	1.0
5425	June 5	0.0	L	1.0
5437	June 8	−0.8	L	0.7
5438	June 8	−0.4	L	0.6*
5730	Sept. 30	−0.8	M	1.0
5731	Sept. 30	−0.4	M	0.9
5752	Oct. 3	−0.8	M	1.0
5753	Oct. 3	−0.4	M	0.9

The normal equations are:

$$23.1c + 10.363\mu - 3.8673\pi = +0.0660 \text{ mm.}$$
$$+ 974.9621\mu - 29.0084\pi = +4.5265 \text{ mm.}$$
$$+ 15.3655\pi = -0.1111 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR ϵ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
50	−0.0343	0.5	+0.880	−730	+0.0028	+0″.04
62	− .0280	1.0	+ .834	−724	− .0033	− .07
63	− .0326	1.0	+ .834	−724	+ .0013	+ .03
69	− .0295	0.7	+ .816	−722	− .0017	− .03
205	− .0318	0.7	− .549	−627	+ .0024	+ .04
253	− .0260	0.7	− .675	−617	− .0031	− .05
281	− .0263	1.0	− .741	−611	− .0027	− .06
282	− .0261	0.7	− .741	−611	− .0029	− .05
339	− .0300	0.7	− .809	−604	+ .0012	+ .02
421	− .0315	0.7	− .950	−579	+ .0036	+ .06
517	− .0258	1.0	− .953	−565	− .0014	− .03
1368	− .0156	0.8	+ .661	−342	+ .0019	+ .04
1369	− .0168	1.0	+ .661	−342	+ .0031	+ .06
1373	− .0170	0.8	+ .649	−341	+ .0033	+ .06
1374	− .0124	0.7	+ .649	−341	− .0013	− .02
4609	+ .0236	1.0	− .945	+515	− .0002	.00
4610	+ .0216	1.0	− .945	+515	+ .0018	+ .04
4621	+ .0247	1.0	− .948	+516	− .0012	− .02
4622	+ .0231	1.0	− .948	+516	+ .0004	+ .01
5424	+ .0411	1.0	+ .788	+742	− .0038	− .08
5425	+ .0390	1.0	+ .788	+742	− .0017	− .04
5437	+ .0374	0.7	+ .758	+745	.0000	.00
5438	+ .0346	0.6	+ .758	+745	+ .0028	+ .05
5730	+ .0405	1.0	− .826	+859	− .0007	− .01
5731	+ .0399	0.9	− .826	+859	− .0001	.00
5752	+ .0387	1.0	− .850	+862	+ .0012	+ .02
5753	+0.0386	0.9	−0.850	+862	+0.0013	+0.02

from which:

$c = + 0.00107$ mm.

$\mu = + 0.00469$ mm. $= + 0''.0975$, or $+ 0''.356$ per year.

$\pi = + 0.00189$ mm. $= + \mathbf{0''.039 \pm 0''.008}$.

Probable error of plate of unit weight

± 0.00142 mm. $= \pm 0''.030$.

η CEPHEI ($20^h\ 43^m$; $+61°\ 27'$)

Five determinations of the parallax of this star have been made, as follows: $+ 0''.088 \pm 0''.037$ from the Yale heliometer by Smith; $+ 0''.241 \pm 0''.028$ from the meridian circle by Abetti; $+ 0''.066 \pm 0''.010$ from photography by Slocum and Mitchell; $+ 0''.066 \pm 0''.007$ by photography at Allegheny; and the spectroscopic parallax of Adams $+ 0''.076$. The star has a considerable proper motion $0''.82$, it is of magnitude 3.59, and of type Ko. Eleven of the plates were measured by Mr. Briggs, the balance of nine by Mr. Mitchell. A relative parallax of $+ 0''.064$

TABLE 1

PLATES OF η CEPHEI

No.	Date.	Hour Angle.	Observers.	Weight.
3189	1916 Oct. 14	$-0^h.7$	M	1.0
3190	Oct. 14	−0.3	L	0.8
3343	Nov. 4	0.0	M	0.7
3374	Nov. 10	+0.2	Ol	0.8
4092	1917 June 18	−1.0	M	1.0
4093	June 18	−1.7	M	1.0
4133	June 29	−0.6	A	0.8
4134	June 29	−0.3	A	1.0
4409	Sept. 11	−0.5	M	1.0
4410	Sept. 11	−0.2	B	1.0
4481	Sept. 29	−0.5	B	1.0
4482	Sept. 29	0.0	B	1.0
5518	1918 July 3	−0.6	Ol	1.0
5519	July 3	−0.1	Ol	0.9
5542	July 13	−0.1	Ol	0.7*
5543	July 13	+0.2	Ol	0.7
5724	Sept. 27	−0.2	M	1.0
5725	Sept. 27	+0.2	M	0.9
5744	Oct. 2	−0.7	M	1.0
5745	Oct. 2	−0.3	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−66.3	−47.6	+0.2795
2	.16	−11.0	+16.6	.2145
3	.12	+19.1	+27.1	.1779
4	.14	+24.3	+14.4	.1707
5	.13	+33.9	−10.5	+0.1574
Parallax star	0.14	− 8.0	− 4.1	

TABLE 2

REDUCTIONS FOR η CEPHEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3189	+0.0094	1.0	−0.919	−391	−0.0023	−0″.05
3190	+ .0044	0.8	− .919	−391	+ .0027	+ .05
3343	+ .0073	0.7	− .955	−370	.0000	.00
3374	+ .0052	0.8	− .942	−364	+ .0022	+ .04
4092	+ .0159	1.0	+ .646	−144	− .0006	− .01
4093	+ .0115	1.0	+ .646	−144	+ .0038	+ .08
4133	+ .0200	0.8	+ .501	−133	− .0050	− .09
4134	+ .0140	1.0	+ .501	−133	+ .0010	+ .02
4409	+ .0129	1.0	− .627	− 59	− .0003	− .01
4410	+ .0166	1.0	− .627	− 59	− .0040	− .08
4481	+ .0109	1.0	− .817	− 41	+ .0013	+ .03
4482	+ .0128	1.0	− .817	− 41	− .0006	− .01
5518	+ .0223	1.0	+ .447	+236	− .0024	− .05
5519	+ .0170	0.9	+ .447	+236	+ .0029	+ .06
5542	+ .0193	0.7	+ .296	+246	+ .0003	+ .01
5543	+ .0203	0.7	+ .296	+246	− .0007	− .01
5724	+ .0150	1.0	− .797	+322	+ .0023	+ .05
5725	+ .0185	0.9	− .797	+322	− .0012	− .02
5744	+ .0206	1.0	− .840	+327	− .0034	− .07
5745	+0.0135	1.0	−0.840	+327	+0.0037	+0.08

$\pm$ 0″.013, which is in close agreement with the photographic values of Yerkes and Allegheny. A proper motion in right ascension + 0″.104 was determined from the plates. The corresponding value from Boss is + 0″.097. The star has a large radial velocity of − 87 km. per second.

The normal equations are:

$$18.3c + 0.772\mu - 5.7011\pi = + 0.2639 \text{ mm.}$$
$$+ 116.2051\mu + 2.6885\pi = + 0.1793 \text{ mm.}$$
$$+ 9.3966\pi = - 0.0547 \text{ mm.}$$

from which:

c = + 0.01532 mm.
μ = + 0.00137 mm. = + 0″.0285, or + 0″.104 per year.
π = + 0.00309 mm. = + **0″.064 $\pm$ 0″.013.**

Probable error of plate of unit weight

$$\pm 0.00175 \text{ mm.} = \pm 0''.036.$$

μ AQUARII (20^h 47^m; −9° 21′)

No parallax has been published for this star of magnitude 4.80, of spectral type F, and of total proper motion 0″.052. Mr. Olivier measured the photographs except five plates measured

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−30.5	+22.6	+0.1571
2	.13	−36.5	− 4.7	.1487
3	.12	− 0.6	+17.8	.1992
4	.11	+30.4	−45.4	.2428
5	.10	+37.2	+ 9.7	+0.2522
Parallax star	0.12	+ 6.4	− 2.1	

by Mr. Mitchell. The relative parallax is small + 0″.005 $\pm$ 0″.008, and the proper motion in right ascension from the plates amounts to + 0″.058, while the corresponding value from Boss is + 0″.037.

TABLE 1

PLATES OF μ AQUARII

No.	Date.	Hour Angle.	Observers.	Weight.
1624	1915 Sept. 8	+0^{h}3	A	1.0
1625	Sept. 8	+0.7	A	0.9
1642	Sept. 10	−0.1	A	0.7
1643	Sept. 10	+0.3	A	0.7
3080	1916 Sept. 24	+0.6	M	0.7
3081	Sept. 24	+1.0	M	0.7
4045	1917 June 7	−0.3	Ol	0.8
4046	June 7	+0.3	Ol	0.7
4064	June 13	−1.1	Ol	0.9
4065	June 13	−0.5	Ol	0.8
4172	July 10	−0.2	Ol	0.6*
4175	July 13	−1.1	Ol	0.6*
4483	Sept. 29	+0.4	Ds, B	0.8
4484	Sept. 29	+0.9	B, Ds	0.9
4501	Oct. 2	0.0	Ds, Ol	0.9
4502	Oct. 2	+0.4	Ol, Ds	0.8
5468	1918 June 19	−0.5	Ol	1.0
5469	June 19	−0.1	Ol	0.9
5474	June 22	−0.8	Ol	0.8
5475	June 22	−0.2	Ol	0.9
5726	Sept. 28	+0.1	M	1.0
5727	Sept. 28	+0.6	M	0.9
5746	Oct. 2	0.0	M	1.0
5747	Oct. 2	+0.5	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR μ AQUARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1624	+0.0004	1.0	−0.567	−676	+0.0020	+0″.04
1625	+ .0037	0.9	− .567	−676	− .0013	− .02
1642	+ .0004	0.7	− .592	−674	+ .0020	+ .04
1643	+ .0062	0.7	− .592	−674	− .0038	− .06
3080	+ .0068	0.7	− .762	−294	− .0015	− .03
3081	+ .0012	0.7	− .762	−294	+ .0041	+ .07
4045	+ .0081	0.8	+ .778	− 38	− .0005	− .01
4046	+ .0064	0.7	+ .778	− 38	+ .0012	+ .02
4064	+ .0107	0.9	+ .716	− 32	− .0031	− .06
4065	+ .0068	0.8	+ .716	− 32	+ .0008	+ .02
4172	+ .0077	0.6	+ .355	− 5	+ .0001	.00
4175	+ .0066	0.6	+ .310	− 2	+ .0012	+ .02
4483	+ .0087	0.8	− .807	+ 76	− .0006	− .01
4484	+ .0083	0.9	− .807	+ 76	− .0002	.00
4501	+ .0076	0.9	− .832	+ 79	+ .0005	+ .01
4502	+ .0102	0.8	− .832	+ 79	− .0021	− .04
5468	+ .0120	1.0	+ .649	+339	− .0015	− .03
5469	+ .0108	0.9	+ .649	+339	− .0003	− .01
5474	+ .0088	0.8	+ .611	+342	+ .0017	+ .03
5475	+ .0086	0.9	+ .611	+342	+ .0019	+ .04
5726	+ .0124	1.0	− .796	+440	− .0015	− .03
5727	+ .0118	0.9	− .796	+440	− .0009	− .02
5746	+ .0111	1.0	− .830	+444	− .0002	.00
5747	+0.0085	1.0	−0.830	+444	+0.0024	+0.05

The normal equations are:

$$20.0c + 4.578\mu - 3.8766\pi = +0.1571 \text{ mm.}$$
$$+ 282.8905\mu + 6.7053\pi = +0.2532 \text{ mm.}$$
$$+ 10.1276\pi = -0.0225 \text{ mm.}$$

from which:

$c = +0.00772$ mm.
$\mu = +0.00076$ mm. $= +0''.0159$ or $+0''.058$ per year.
$\pi = +0.00023$ mm. $= +\mathbf{0''.005 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00117 \text{ mm.} = \pm 0''.024.$$

ϵ EQUULEI ($20^h\ 54^m$; $+3°\ 55'$)

This forms a triple physical system. The components have a common proper motion, $0''.22$. The pair Σ 2737 are close, and of nearly equal magnitudes, 5.8 and 6.3, respectively, which are never separated more than $1''.1$. The orbit for this pair has been found by Russell (*Astronomical Journal*, **30**, 123, 1917), with a period of 97.4 years, and $a = 0''.61$. $10''$ distant from this pair AB which is of F5 type, is the star C of magnitude 7.1. The photographic parallax of Swarthmore is $+0''.018 \pm 0''.012$, the spectroscopic value for AB and C are $+0''.021$ and $+0''.015$, respectively. Mr. Mitchell measured the McCormick plates, and found the parallax of AB to be $\pm 0''.021 \pm 0''.010$, and the parallax of C to be $+0''.002 \pm 0''.011$. These combined give a relative parallax of the system:

$$\mathbf{+ 0''.011 \pm 0''.007}.$$

This gives the absolute value of the parallax to be $+0''.016$. Using this value, and Russell's orbit, then the mass of the system is equal to 5.8 times that of the sun. The proper motion in right ascension from the plates is $-0''.125$ for the pair AB, and $-0''.135$ for the companion C. Boss gives the value $-0''.126$.

TABLE 1

PLATES OF ϵ EQUULEI

No.	Date.	Hour Angle.	Observers.	Weight.
79	1914 June 17	+0h3	M	0.6
80	June 17	−0.3	M	0.6
85	June 19	0.0	M, Ol	0.6
86	June 19	+0.4	M, Ol	0.6
230	Sept. 13	+0.4	M, G	0.4
272	Sept. 20	+0.9	M	0.8
273	Sept. 20	+1.5	M	0.7
351	Sept. 29	+1.4	A, M	0.7
423	Oct. 23	+0.7	M	0.7
435	Oct. 30	+0.7	G	0.8
548	Nov. 11	+0.1	M	1.0
580	Nov. 17	+0.4	M	0.6
1370	1915 June 17	+0.1	G	1.0
1371	June 17	+0.5	G	0.7
1376	June 19	−0.6	M	0.7
1377	June 19	−0.2	M	0.7
1378	June 19	+0.3	M	0.7
4611	1917 Oct. 21	0.0	M	1.0
4612	Oct. 21	+0.2	M	1.0
4623	Oct. 22	+0.1	A	1.0
4624	Oct. 22	+0.3	A	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependences.	
				AB	C
	mm.	mm.	mm.		
1	0.24	−55.1	−15.0	+0.176	+0.171
2	.12	−30.6	+17.0	.218	.217
3	.14	+12.0	+26.7	.234	.237
4	.20	+26.7	− 2.0	.200	.202
5	.20	+47.0	−26.7	+0.172	+0.173
Principal star, AB	.20	− 0.1	+ 2.3		
Companion, C	0.12	+ 0.4	+ 2.4		

TABLE 2

REDUCTIONS FOR ϵ EQUULEI, PRINCIPAL STAR, AB

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
79	+0.0038	0.6	+0.692	−365	+0.0001	0″.00
80	+ .0080	0.6	+ .692	−365	− .0041	− .07
85	+ .0064	0.6	+ .668	−363	− .0025	− .04
86	+ .0072	0.6	+ .668	−363	− .0033	− .05
230	+ .0022	0.4	− .610	−277	− .0010	− .01
272	+ .0027	0.8	− .694	−270	− .0017	− .03
273	− .0008	0.7	− .694	−270	+ .0018	+ .03
351	+ .0028	0.7	− .786	−261	− .0021	− .04
423	− .0009	0.7	− .937	−237	+ .0011	+ .02
435	+ .0001	0.8	− .951	−230	− .0001	.00
548	− .0027	1.0	− .944	−218	+ .0026	+ .05
580	− .0014	0.6	− .924	−212	+ .0012	+ .02
1370	− .0042	1.0	+ .694	0	+ .0021	+ .04
1371	− .0051	0.7	+ .694	0	+ .0030	+ .05
1376	+ .0008	0.7	+ .671	+ 2	− .0029	− .05
1377	− .0050	0.7	+ .671	+ 2	+ .0029	+ .05
1378	− .0049	0.7	+ .671	+ 2	+ .0028	+ .05
4611	− .0158	1.0	− .931	+857	− .0020	− .04
4612	− .0178	1.0	− .931	+857	.0000	.00
4623	− .0184	1.0	− .934	+858	+ .0006	+ .01
4624	−0.0172	1.0	−0.934	+858	−0.0006	−0.01

The normal equations are:

$$15.9c + 11.670\mu - 4.2594\pi = -0.0678 \text{ mm.}$$
$$+ 360.3082\mu - 26.4372\pi = -0.6519 \text{ mm.}$$
$$+ 10.3979\pi = +0.0659 \text{ mm.}$$

from which:

$c = -0.00278$ mm.

$\mu = -0.00164$ mm. $= -0''.0342$, or $-0''.125$ per year.

$\pi = +0.00101$ mm. $= +\mathbf{0''.021 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00133 \text{ mm.} = \pm 0''.028.$$

TABLE 3

REDUCTIONS FOR ϵ EQUULEI, COMPANION, C

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
79	+0.0599	0.6	+0.692	−365	−0.0030	−0″.05
80	+ .0582	0.6	+ .692	−365	− .0013	− .02
85	+ .0535	0.6	+ .668	−363	+ .0033	+ .05
86	+ .0559	0.6	+ .668	−363	+ .0009	+ .01
230	+ .0563	0.4	− .610	−277	− .0011	− .01
351	+ .0563	0.7	− .786	−261	− .0014	− .02
423	+ .0498	0.7	− .937	−237	+ .0046	+ .08
435	+ .0528	0.8	− .951	−230	+ .0015	+ .03
548	+ .0557	1.0	− .944	−218	− .0016	− .03
580	+ .0567	0.6	− .924	−212	− .0027	− .04
1370	+ .0510	1.0	+ .694	0	− .0006	− .01
1371	+ .0475	0.7	+ .694	0	+ .0029	+ .05
1376	+ .0490	0.7	+ .671	+ 2	+ .0013	+ .02
1377	+ .0543	0.7	+ .671	+ 2	− .0040	− .07
1378	+ .0492	0.7	+ .671	+ 2	+ .0011	+ .02
4611	+ .0364	1.0	− .931	+857	− .0015	− .03
4612	+ .0326	1.0	− .931	+857	+ .0023	+ .05
4623	+ .0346	1.0	− .934	+858	+ .0003	+ .01
4624	+0.0362	1.0	−0.934	+858	−0.0013	−0.03

The normal equations are:

$$14.4c + 15.720\mu - 3.2184\pi = + 0.6960 \text{ mm.}$$
$$+ 349.3732\mu - 29.2479\pi = + 0.1655 \text{ mm.}$$
$$+ 9.6754\pi = - 0.1089 \text{ mm.}$$

from which:

$c = + 0.05030$ mm.

$\mu = - 0.00178$ mm. $= - 0''.0371$, or $- 0''.135$ per year.

$\pi = + 0.00008$ mm. $= + \mathbf{0''.002 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00139 \text{ mm.} = \pm 0''.029.$$

W_1 20^h 1454 (20^h 59^m; $+2°$ 36′)

This star of magnitude 8.0, of type F8 has a total proper motion 0″.485. With the heliometer Smith has twice measured the parallax with the results, − 0″.134 ± 0″.048 and − 0″.075 ± 0″.013. With the spectrograph Mt. Wilson finds the absolute parallax + 0″.015. Mr. Olivier measured the plates and derived a parallax + 0″.005 ± 0″.009 with a proper motion in right ascension − 0″.289 where the corresponding value from Porter is − 0″.297.

TABLE 1

PLATES OF W_1 20^h 1454

No.	Date.	Hour Angle.	Observers.	Weight.
3346	1916 Nov. 5	+0^{h}5	M	1.0
3375	Nov. 10	+0.5	Ol	0.9
3376	Nov. 10	+0.9	Ol	1.0
3399	Nov. 18	+0.3	M	0.9
3400	Nov. 18	+0.7	M	0.8
4096	1917 June 18	+0.2	M	0.8
4097	June 18	+0.6	M	0.9
4108	June 22	+0.7	A	0.9
4490	Oct. 1	+0.3	Ds, A	0.7
4559	Oct. 11	+0.6	B	0.9
4560	Oct. 11	+0.9	B	0.9
4738	Nov. 8	+0.1	M	0.8
5428	1918 June 7	−1.2	Ol	0.7
5429	June 7	−0.7	Ol	0.7
5470	June 19	+0.4	Ol	0.7*
5471	June 19	+0.8	Ol	0.9
5760	Oct. 4	+0.2	F, H	0.9
5761	Oct. 4	+0.6	F, H	0.8
5778	Oct. 9	+0.4	F, D	0.9
5779	Oct. 9	+0.8	F, D	0.9
7108	1919 May 28	−1.8	Ol	0.8
7109	May 28	−1.4	Ol	0.8
7110	May 28	−1.0	Ol	0.8
7111	May 28	−0.6	Ol	0.9

* One exposure.

TABLE 2

REDUCTIONS FOR W_1 20^h 1454

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3346	+0.0007	1.0	−0.951	−440	+0.0004	+0″.01
3375	+ .0008	0.9	− .945	−435	+ .0001	.00
3376	− .0014	1.0	− .945	−435	+ .0023	+ .05
3399	+ .0005	0.9	− .921	−427	+ .0001	.00
3400	− .0035	0.8	− .921	−427	+ .0041	+ .08
4096	− .0055	0.8	+ .691	−215	− .0016	− .03
4097	− .0078	0.9	+ .691	−215	+ .0007	+ .01
4108	− .0018	0.9	+ .643	−211	− .0054	− .11
4490	− .0094	0.7	− .793	−110	− .0020	− .04
4559	− .0090	0.9	− .872	−100	− .0028	− .06
4560	− .0128	0.9	− .872	−100	+ .0010	+ .02
4738	− .0142	0.8	− .949	− 72	+ .0013	+ .02
5428	− .0193	0.7	+ .806	+139	− .0012	− .02
5429	− .0209	0.7	+ .806	+139	+ .0004	+ .01
5470	− .0209	0.7	+ .682	+151	− .0001	.00
5471	− .0213	0.9	+ .682	+151	+ .0003	+ .01
5760	− .0278	0.9	− .818	+258	+ .0023	+ .05
5761	− .0227	0.8	− .818	+258	− .0028	− .05
5778	− .0259	0.9	− .856	+263	+ .0002	.00
5779	− .0216	0.9	− .856	+263	− .0041	− .08
7108	− .0324	0.8	+ .886	+394	+ .0022	+ .04
7109	− .0321	0.8	+ .886	+394	+ .0019	+ .04
7110	− .0312	0.8	+ .886	+394	+ .0010	+ .02
7111	−0.0318	0.9	+0.886	+394	+0.0016	+0.03

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−26.0	+ 0.6	+0.1360
2	.23	−18.5	− 6.8	.1325
3	.10	− 8.0	+43.2	.3105
4	.27	+26.0	− 4.7	.2517
5	.24	+26.5	−32.3	+0.1693
Parallax star	0.22	+ 2.5	+ 5.9	

The normal equations are:

$$20.3c - 2.140\mu - 3.2307\pi = -0.3060 \text{ mm.}$$
$$+ 182.5828\mu + 24.7564\pi = - 0.6555 \text{ mm.}$$
$$+ 14.4570\pi = - 0.0407 \text{ mm.}$$

from which:

$c = - 0.01543$ mm.

$\mu = - 0.00381$ mm. $= - 0''.0791$, or $- 0''.289$ per year.

$\pi = + 0.00025$ mm. $= + \mathbf{0''.005 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00145 \text{ mm.} = \pm 0''.030.$$

61 CYGNI ($21^h\ 2^m$; $+38°\ 15'$)

No stars in the sky have received more attention than the pair called 61 Cygni. As is well known, they have a very large and nearly common proper motion amounting to $5''.16$ per year, they are of 5.6 and 6.3 magnitude, respectively, and both are of K5 type. Since the parallax was first determined by Bessel in 1838 by the heliometer, the stars have been many times investigated to determine their distance. The results are naturally very discordant, the heliometer values in themselves having a range from $+ 0''.18$ to $+ 0''.56$. Bessel's parallax was $0''.31$. It will not be necessary here to give a complete list of the determinations of parallax, for these have been many times published. The more recent results are given in *Publications of Yerkes Observatory*, **4**, 22, 1917. In the *Astrophysical Journal*, **46**, 326, 1917, Adams gives the weighted mean of sixteen of the better

class of measures. He finds the values of the absolute parallax for 61^1 Cygni to be + 0″.313; and for 61^2 Cygni to be + 0″.309. To change these absolute values so as to find the relative parallax for the more recent parallax work by large telescopes, 0″.005 should be subtracted from the absolute parallax. Hence, the mean value of the relative parallax from sixteen authorities amounts to + 0″.308 and + 0″.304 for 61^1 and 61^2 Cygni, respectively.

On account of the historical interest, the star was placed on the McCormick observing program. The following values of the relative parallax have been recently found by photography from five different telescopes in the United States, each of great focal length.

Relative Parallax.		Authority.	Telescope.
61^1 Cygni.	61^2 Cygni.		
+0″.267±0″.004	+0″.277±0″.006	Slocum	40-in. Yerkes refractor
+ .301± .009	+ .299± .021	Miller	24-in. Swarthmore refractor
+ .325± .011	+ .320± .008	Van Maanen	60-in. Mt. Wilson reflector
+ .282± .009	+ .286± .007	Allegheny	30-in. Allegheny refractor
+0.306±0.005	+0.308±0.006	Mitchell	26-in. McCormick refractor

By comparing the results above, it will be noticed that there is still a considerable range among the values. The absolute values of the parallaxes, as determined by Adams by the spectrograph amount to + 0″.322, and + 0″.288 for 61^1 and 61^2 Cygni, respectively.

On account of the special interest attaching to this star, Mr. Mitchell made a careful selection of the comparison stars with the idea of testing the relative merits of different combinations. In accord with the usual practice at the McCormick Observatory, a group of comparison stars numbering five were selected. In addition to these, another group of three were selected, and

these two separate groups were chosen so that they could be combined and make a system of eight comparison stars. Stars 1, 2, 3, 4 and 5 in the list of Comparison Stars in Table I formed the five-star combination; while 6, 7 and 8 were the three-star group. The plates were, of course, measured only once, so that the parallax stars and the comparison stars to the number of eight were measured. The results were then reduced entirely independently, on the basis of: (*a*) 3-comparison stars, (*b*) 5-comparison stars, and (*c*) 8-comparison stars. Before the solutions were made, it was expected that the five-comparison stars would show considerably smaller probable errors than the three comparison stars, but that the increase in accuracy of eight stars over five would be very little. The results for the three separate solutions follow:

For 61^1 Cygni,

	3-star.	5-star.	8-star.
π =	$+ 0''.308 \pm 0''.008$	$+ 0''.300 \pm 0''.005$	$+ 0''.306 \pm 0''.005$

For 61^2 Cygni,

	3-star.	5-star.	8-star.
π =	$+ 0''.315 \pm 0''.009$	$+ 0''.304 \pm 0''.006$	$+ 0''.308 \pm 0''.006$

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependences.	
				61^1.	61^2.
	mm.	mm.	mm.		
1	0.14	−46.7	−20.6	+0.125	+0.123
2	.11	−16.1	+25.6	.121	.116
3	.12	+15.3	+15.2	.124	.124
4	.14	+21.9	− 3.1	.127	.129
5	.10	+25.0	−18.9	.129	.134
6	.10	−55.2	+13.9	.120	.113
7	.14	+17.8	−46.1	.131	.139
8	.18	+38.0	+34.0	+0.123	+0.122
61^1 Cygni	.12	+ 0.5	− 0.6		
61^2 Cygni	0.10	+ 1.3	− 1.3		

The eight comparison star solutions give naturally the most reliable results, and those values are adopted as best representing

the McCormick measures. Proper motions from the plates amounted in right ascension to + 4″.161 and + 4″.161, respectively for 61¹ and 61² Cygni, while the values from Boss are + 4″.148 and + 4″.134.

Since these stars unquestionably form a physical system, the combined results of 61¹ and 61² Cygni give the McCormick value of the relative parallax of the system to be:

+ 0″.307 ± 0″.004.

TABLE 1

PLATES OF 61 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
1838	1915 Oct. 24	−0ʰ.2	M	1.0
1853	Oct. 25	−0.4	M	1.0
1854	Oct. 25	0.0	M	1.0
1974	Nov. 7	−0.1	M	1.0
2720	1916 June 17	−0.4	M	0.7
2721	June 17	−0.1	M	0.7
2739	June 19	−0.5	M	0.7
2740	June 19	−0.2	M	0.7
2757	June 22	−0.3	M	0.7
2777	June 26	−0.8	M	0.7
2778	June 26	−0.4	M	0.7
3258	Oct. 24	−0.2	M	1.0
3351	Nov. 7	−0.1	M	1.0
3366	Nov. 8	−0.4	M	1.0
3367	Nov. 8	−0.1	M	1.0
3378	Nov. 11	−0.1	M	1.0
4038	1917 June 4	−0.4	A	1.0
4052	June 8	−0.5	A	1.0
4053	June 8	−0.2	A	1.0
4072	June 16	−0.5	A	1.0
4073	June 16	−0.1	A	1.0
4471	Sept. 26	−0.5	M	1.0
4472	Sept. 26	−0.2	M	1.0
4557	Oct. 11	−0.4	A	1.0
4558	Oct. 11	−0.1	A, B	1.0

TABLE 2

REDUCTIONS FOR 61[1] CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1838	−0.0214	1.0	−0.929	−375	−0.0010	−0″.02
1853	− .0208	1.0	− .932	−374	− .0011	− .02
1854	− .0214	1.0	− .932	−374	− .0005	− .01
1974	− .0163	1.0	− .949	−361	+ .0012	+ .02
2720	+ .1261	0.7	+ .834	−151	+ .0003	.00
2721	+ .1278	0.7	+ .834	−151	− .0014	− .02
2739	+ .1291	0.7	+ .685	−136	+ .0033	+ .06
2740	+ .1306	0.7	+ .685	−136	+ .0018	+ .03
2757	+ .1324	0.7	+ .650	−133	+ .0011	+ .02
2777	+ .1367	0.7	+ .601	−129	− .0017	− .03
2778	+ .1352	0.7	+ .601	−129	− .0002	.00
3258	+ .1790	1.0	− .932	− 9	− .0008	− .02
3351	+ .1869	1.0	− .949	+ 5	− .0012	− .02
3366	+ .1840	1.0	− .948	+ 6	+ .0022	+ .05
3367	+ .1847	1.0	− .948	+ 6	+ .0015	+ .03
3378	+ .1889	1.0	− .943	+ 9	− .0009	− .02
4038	+ .3264	1.0	+ .836	+214	+ .0002	.00
4052	+ .3285	1.0	+ .801	+218	− .0003	− .01
4053	+ .3300	1.0	+ .801	+218	− .0018	− .04
4072	+ .3316	1.0	+ .721	+226	− .0002	.00
4073	+ .3314	1.0	+ .721	+226	.0000	.00
4471	+ .3669	1.0	− .736	+328	− .0010	− .02
4472	+ .3651	1.0	− .736	+328	+ .0008	+ .02
4557	+ .3736	1.0	− .865	+343	− .0014	− .03
4558	+0.3702	1.0	−0.865	+343	+0.0020	+0.04

The normal equations are:

$$22.9c + 3.015\mu - 4.3610\pi = + 4.6098 \text{ mm.}$$
$$+ 133.7914\mu + 6.7392\pi = + 8.0295 \text{ mm.}$$
$$+ 15.9905\pi = - 0.2536 \text{ mm.}$$

from which:

$c = +0.19689$ mm.

$\mu = +0.05484$ mm. $= +1''.1406$, or $+4''.161$ per year.

$\pi = +0.01473$ mm. $= +\mathbf{0''.306} \pm \mathbf{0''.005}$.

Probable error corresponding to unit weight

$$\pm 0.00090 \text{ mm.} = \pm 0''.019.$$

TABLE 3

REDUCTIONS FOR 61² CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1838	+0.0074	1.0	−0.929	−375	+0.0012	+0″.02
1853	+ .0104	1.0	− .932	−374	− .0012	− .02
1854	+ .0104	1.0	− .932	−374	− .0012	− .02
1974	+ .0154	1.0	− .949	−361	+ .0006	+ .01
2720	+ .1608	0.7	+ .834	−151	− .0033	− .06
2721	+ .1596	0.7	+ .834	−151	− .0021	− .04
2739	+ .1602	0.7	+ .685	−136	+ .0033	+ .06
2740	+ .1589	0.7	+ .685	−136	+ .0046	+ .08
2757	+ .1625	0.7	+ .650	−133	+ .0021	+ .04
2777	+ .1687	0.7	+ .601	−129	− .0026	− .05
2778	+ .1663	0.7	+ .601	−129	− .0002	.00
3258	+ .2087	1.0	− .932	− 9	+ .0004	+ .01
3351	+ .2171	1.0	− .949	+ 5	− .0005	− .01
3366	+ .2167	1.0	− .948	+ 6	+ .0004	+ .01
3367	+ .2168	1.0	− .948	+ 6	+ .0003	+ .01
3378	+ .2196	1.0	− .943	+ 9	− .0008	− .02
4038	+ .3554	1.0	+ .836	+214	+ .0021	+ .04
4052	+ .3584	1.0	+ .801	+218	+ .0008	+ .02
4053	+ .3607	1.0	+ .801	+218	− .0015	− .03
4072	+ .3620	1.0	+ .721	+226	+ .0004	+ .01
4073	+ .3652	1.0	+ .721	+226	− .0028	− .06
4471	+ .3970	1.0	− .736	+328	− .0003	− .01
4472	+ .3977	1.0	− .736	+328	− .0010	− .02
4557	+ .4028	1.0	− .865	+343	+ .0002	.00
4558	+0.4016	1.0	−0.865	+343	+0.0014	+0.03

The normal equations are:

$$22.9c + 3.015\mu - 4.3610\pi = + 5.3192 \text{ mm.}$$
$$+ 133.7914\mu + 6.7392\pi = + 8.1178 \text{ mm.}$$
$$+ 15.9905\pi = - 0.3878 \text{ mm.}$$

from which:

$c = + 0.22788$ mm.
$\mu = + 0.05479$ mm. $= + 1.1397$, or $+ 4''.161$ per year.
$\pi = + 0.01480$ mm. $= + \mathbf{0''.308 \pm 0''.006}$.

Probable error corresponding to unit weight

$$\pm 0.00117 \text{ mm.} = \pm 0''.024.$$

ζ CYGNI ($21^h\ 8^m$; $+29°\ 49'$)

The Allegheny Observatory by photography finds the relative parallax of $+ 0''.014 \pm 0''.007$, while the spectrographic value of Adams gives the absolute parallax of $+ 0''.013$. The star is of 3.40 magnitude, of Ko type, and of small proper motion $0''.06$. Mr. Alden measured the McCormick series of photographs except the last eight which were measured by Mr. Mitchell. The proper motion in right ascension from the photographs was found to be $- 0''.002$ per year, while the value from Boss is $- 0''.003$. Stebbins and Burns (*Lick Observatory Bulletin*, **4**, 97, 1906), have found the star to be a spectroscopic binary of long period.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−58.2	+28.8	+0.2383
2	.12	−10.2	+42.0	.1710
3	.20	+10.7	−43.7	.3321
4	.14	+57.7	−27.1	+0.2586
Parallax star	0.14	+ 2.9	− 7.5	

TABLE 1

PLATES OF ζ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
329	1914 Sept. 27	-0^h1	M	1.0
387	Oct. 10	−0.2	M	0.7
573	Nov. 13	−0.1	M	1.0
1436	1915 July 6	−0.2	A	1.0
1493	July 18	−0.2	A	1.0
1510	July 24	−0.3	A	0.8
1511	July 24	0.0	A	0.9
1734	Sept. 22	−0.2	A	0.9
1934	Oct. 31	−0.3	M	0.6*
1935	Oct. 31	0.0	M	1.0
1944	Nov. 2	−0.4	M	1.0
2789	1916 July 3	−1.4	M	1.0
2790	July 3	−1.0	M	1.0
2828	July 20	−0.4	L	0.8
5439	1918 June 8	−0.2	L	0.8
5496	July 1	−0.6	A	0.9
5497	July 1	−0.3	A	0.8
5536	July 10	−0.3	A	0.8
5737	Oct. 1	+0.3	M	0.9
5738	Oct. 1	−0.3	M	0.9
5776	Oct. 9	−0.7	F, D	0.9
5777	Oct. 9	−0.4	D, F	0.9

* One exposure.

The normal equations are:

$$19.6c - 2.140\mu - 3.7479\pi = +0.0372 \text{ mm.}$$
$$+580.6616\mu + 11.2036\pi = -0.0065 \text{ mm.}$$
$$+9.2348\pi = +0.0040 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR ζ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
329	+0.0027	1.0	−0.725	−732	−0.0013	−0″.03
387	+ .0002	0.7	− .842	−719	+ .0010	+ .02
573	+ .0020	1.0	− .941	−685	− .0009	− .02
1436	+ .0036	1.0	+ .498	−450	− .0006	− .01
1493	+ .0012	1.0	+ .323	−438	+ .0015	+ .03
1510	− .0005	0.8	+ .230	−432	+ .0031	+ .06
1511	+ .0078	0.9	+ .230	−432	− .0052	− .10
1734	+ .0006	0.9	− .683	−372	+ .0007	+ .01
1934	+ .0001	0.6	− .942	−333	+ .0009	+ .01
1935	+ .0018	1.0	− .942	−333	− .0008	− .02
1944	− .0014	1.0	− .944	−331	+ .0024	+ .05
2789	+ .0032	1.0	+ .529	− 87	− .0003	− .01
2790	+ .0027	1.0	+ .529	− 87	+ .0002	.00
2828	+ .0012	0.8	+ .281	− 70	+ .0014	+ .02
5439	+ .0002	0.8	+ .816	+618	+ .0029	+ .05
5496	+ .0018	0.9	+ .562	+641	+ .0009	+ .02
5497	+ .0044	0.8	+ .562	+641	− .0017	− .03
5536	+ .0046	0.8	+ .438	+650	− .0020	− .04
5737	+ .0033	0.9	− .765	+733	− .0024	− .05
5738	+ .0032	0.9	− .765	+733	− .0023	− .05
5776	− .0004	0.9	− .835	+741	+ .0012	+ .02
5777	−0.0016	0.9	−0.835	+741	+0.0024	+0″.05

from which:

$c = +\ 0.00215$ mm.

$\mu = -\ 0.00003$ mm. $= -\ 0''.0006$, or $-\ 0''.002$ per year.

$\pi = +\ 0.00134$ mm. $= +\ \mathbf{0''.028 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm\ 0.00135 \text{ mm.} = \pm\ 0''.028.$$

δ EQUULEI ($21^h\ 9^m$; $+9°\ 36'$)

According to Aitken (*Publications of the Lick Observatory*, **12**, 158, 1914), "the revolution period of δ *Equulei* is not only the

shortest known of any visual binary star, but it is the one determined with greatest accuracy." The period is 5.7 years, the semi-major axis, a, is 0″.27, and the magnitudes of the components are 5.3 and 5.4. In view of the short period, the surest plan of freeing the parallax measures from the effect of orbital motion seemed to be to allow the photographic plates to extend in time throughout a whole period of the pair. This was accordingly done. The two stars of the pair are almost equally bright. If they are also equally massive, then the center of mass and center of brightness will coincide. In photographing, the rotating sector was used. The image on the plate which was measured was evidently the center of brightness of the pair. Any uncertainty seemed to be eliminated by allowing the plates to extend over a considerable period of time. Mr. Olivier measured the McCormick plates, and determined a relative parallax of + 0″.041 ± 0″.007 with a proper motion in right ascension + 0″.029, while the corresponding value from Boss is + 0″.041. Other values of the parallax are + 0″.017 ± 0″.035 by the use of the equatorial by Leavenworth; + 0″.02 ± 0″.041 by Flint with the meridian circle, and the absolute value by Adams from the spectroscope of + 0″.060. Hussey obtained an absolute parallax of + 0″.071. The system has a considerable proper motion 0″.306 per year. Assuming the value of the parallax from the McCormick plates, the mass of the system is 6.2 times that of the sun.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−68.9	−15.7	+0.1296
2	.12	−67.2	+30.4	.1999
3	.10	+25.6	+12.5	.1905
4	.14	+34.4	− 2.7	.1691
5	.16	+36.6	− 9.0	.1600
6	.16	+39.5	−15.4	+0.1509
Parallax star	0.14	+ 0.2	+ 2.2	

TABLE 1

PLATES OF δ EQUULEI

No.	Date.	Hour Angle.	Observers.	Weight.
231	1914 Sept. 13	+1h0	M, G	0.9
255	Sept. 15	+1.0	M, G	0.9
263	Sept. 19	+1.2	M, A	0.9
284	Sept. 21	+0.6	M	0.8
398	Oct. 12	+0.5	Ol, G	0.6
475	Nov. 3	+0.1	A	1.0
526	Nov. 9	+0.5	Ol	1.0
623	Nov. 23	+0.5	Ol	0.9
1355	1915 June 9	−0.6	Ol	0.9
1356	June 9	−0.2	Ol	0.7
1484	July 17	+0.3	Ol	0.6
1485	July 17	+1.1	Ol	0.6
1805	Oct. 10	+0.1	M	0.7
1816	Oct. 11	−0.1	G	0.7
1817	Oct. 11	+0.4	G	0.8
1984	Nov. 8	+0.3	Ol	0.8
2001	Nov. 10	−0.3	Ol	0.4
2029	Nov. 17	+0.2	Ol	0.8
3471	1916 Dec. 2	+1.1	M	0.9
3494	Dec. 7	+1.4	M	1.0
4084	1917 June 17	+0.3	Ol	0.7
4144	June 30	−0.9	Ol	0.9
4145	June 30	−0.4	Ol	0.8
4715	Nov. 6	+0.3	Ol	0.9
4716	Nov. 6	+0.9	Ol	1.0
4739	Nov. 9	−0.1	Ol	1.0
4740	Nov. 9	+0.4	Ol	1.0
5476	1918 June 22	+0.2	Ol	1.0
5480	June 23	−0.4	Ol	0.9
5481	June 23	+0.2	Ol	0.9

TABLE 2

REDUCTIONS FOR δ EQUULEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
231	−0.0009	0.9	−0.554	−574	+0.0018	+0″.04
255	+ .0034	0.9	− .582	−572	− .0025	− .05
263	+ .0022	0.9	− .632	−568	− .0014	− .03
284	+ .0028	0.8	− .656	−566	− .0020	− .04
398	− .0008	0.6	− .678	−564	+ .0015	+ .02
475	+ .0032	1.0	− .945	−523	− .0028	− .06
526	+ .0002	1.0	− .946	−517	+ .0002	.00
623	+ .0012	0.9	− .908	−503	− .0007	− .01
1355	+ .0051	0.9	+ .811	−305	− .0005	− .01
1356	+ .0012	0.7	+ .811	−305	+ .0034	+ .06
1484	+ .0056	0.6	+ .341	−267	− .0018	− .03
1485	+ .0012	0.6	+ .341	−267	+ .0026	+ .05
1805	+ .0025	0.7	− .838	−182	− .0006	− .01
1816	+ .0024	0.7	− .846	−181	− .0005	− .01
1817	− .0022	0.8	− .846	−181	+ .0041	+ .07
1984	− .0009	0.8	− .947	−153	+ .0027	+ .05
2001	+ .0028	0.4	− .946	−151	− .0010	− .01
2029	+ .0026	0.8	− .932	−144	− .0008	− .01
3471	+ .0011	0.9	− .851	+237	+ .0024	+ .04
3494	+ .0010	1.0	− .812	+242	+ .0026	+ .05
4084	+ .0090	0.7	+ .729	+434	− .0017	− .03
4144	+ .0071	0.9	+ .575	+447	.0000	.00
4145	+ .0070	0.8	+ .575	+447	.0000	.00
4715	+ .0059	0.9	− .947	+576	− .0013	− .02
4716	+ .0032	1.0	− .947	+576	+ .0014	+ .03
4739	+ .0066	1.0	− .946	+579	− .0020	− .04
4740	+ .0052	1.0	− .946	+579	− .0006	− .01
5476	+ .0100	1.0	+ .676	+804	− .0014	− .03
5480	+ .0094	0.9	+ .664	+805	− .0008	− .02
5481	+0.0077	0.9	+0.664	+805	+0.0009	+0.02

The normal equations are:

$$25.0c + 6.926\mu - 9.1716\pi = + 0.0901 \text{ mm.}$$
$$+ 614.2534\mu + 25.9574\pi = + 0.3160 \text{ mm.}$$
$$+ 15.6075\pi = + 0.0017 \text{ mm.}$$

from which:

$c = + 0.00421$ mm.
$\mu = + 0.00038$ mm. $= + 0''.0080$, or $+ 0''.029$ per year.
$\pi = + 0.00195$ mm. $= + \mathbf{0''.041 \pm 0''.007.}$

Probable error of plate of unit weight

$$\pm 0.00113 \text{ mm.} = \pm 0''.024.$$

τ CYGNI ($21^h\ 10^m$; $+37°\ 37'$)

This star is of more than usual interest to the McCormick Observatory for the reason than in 1874 while testing the 26-inch objective of the McCormick telescope the star was found to be a close double by Alvan G. Clark. The star is a difficult one to measure since the magnitudes are 3.8 and 8.0, and the distance always small. The best orbit is probably that of Aitken (*Publications of the Lick Observatory*, **12**, 160). The period is there given as 47.0 years and the value of $a = 0''.91$. The parallax has been several times determined with rather discordant results, as follows:

Parallax.	Authority.	Method.
$+0''.08 \pm 0''.06$	Wagner-Belopolsky	Meridian circle
$+ .125 \pm .042$	Jost	Meridian circle
$+ .029 \pm .039$	Abetti	Meridian circle
$+ .006 \pm .016$	Slocum and Mitchell	Photography
$+ .023 \pm .014$	Swarthmore	Photography
$+ .058 \pm .010$	Allegheny	Photography
$+0.042$	Adams	Spectrograph

Miss France measured the McCormick plates and determined the relative parallax $+ 0''.046 \pm 0''.007$, and a proper motion in right ascension $+ 0''.159$ where the corresponding value from Boss is $+ 0''.158$. The mean of the four values by photography is $+ 0''.033$. With this value of the parallax and Aitken's orbit, the mass of the system is 6.15 times that of the sun.

TABLE 1

PLATES OF τ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
3180	1916 Oct. 12	$-0^h.3$	A	1.0
3214	Oct. 19	−0.1	M	0.9
4594	1917 Oct. 17	−0.8	B	1.0
4595	Oct. 17	−0.5	B	1.0
4677	Nov. 2	−0.1	M	1.0
4726	Nov. 7	−0.2	M	0.9
5554	1918 July 14	−0.3	A	1.0
5555	July 14	0.0	A	0.9
5565	July 20	−0.5	A	1.0
5566	July 20	−0.2	A	1.0
5732	Sept. 30	−0.6	M	0.9
5733	Sept. 30	−0.2	M	0.8
5754	Oct. 3	−0.5	M, F	1.0
5755	Oct. 3	−0.2	H, F	0.9
7083	1919 May 25	−1.3	H	1.0
7084	May 25	−1.0	H	1.0
7104	May 27	−1.0	H	1.2*
7119	May 29	−1.2	F	1.0
7120	May 29	−0.8	F	1.0
7776	Sept. 24	−0.5	A	1.0
7777	Sept. 24	−0.1	A	1.0
7962	Oct. 20	−0.4	F	1.0
7963	Oct. 20	−0.1	F	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−49.4	+19.3	+0.184
2	.09	−25.9	−32.5	.201
3	.14	− 1.7	+27.8	.194
4	.11	+35.7	+14.5	.205
5	.14	+41.3	−29.1	+0.216
Parallax star	0.13	+ 1.6	− 0.9	

TABLE 2

REDUCTIONS FOR τ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3180	−0.0240	1.0	−0.856	−701	+0.0029	+0″.06
3214	− .0198	0.9	− .898	−694	− .0012	− .02
4594	− .0118	1.0	− .886	−331	− .0016	− .03
4595	− .0130	1.0	− .886	−331	− .0004	− .01
4677	− .0114	1.0	− .943	−315	− .0018	− .04
4726	− .0140	0.9	− .946	−310	+ .0010	+ .02
5554	− .0030	1.0	+ .387	− 61	− .0019	− .04
5555	− .0085	0.9	+ .387	− 61	+ .0036	+ .07
5565	− .0034	1.0	+ .296	− 55	− .0015	− .03
5566	− .0028	1.0	+ .296	− 55	− .0021	− .04
5732	− .0080	0.9	− .750	+ 17	+ .0022	+ .04
5733	− .0070	0.8	− .750	+ 17	+ .0012	+ .02
5754	− .0036	1.0	− .779	+ 20	− .0022	− .05
5755	− .0072	0.9	− .779	+ 20	+ .0014	+ .03
7083	+ .0036	1.0	+ .917	+254	− .0007	− .01
7084	+ .0028	1.0	+ .917	+254	+ .0001	.00
7104	+ .0023	1.2	+ .907	+256	+ .0006	+ .01
7119	+ .0042	1.0	+ .895	+258	− .0012	− .02
7120	+ .0008	1.0	+ .895	+258	+ .0022	+ .05
7776	+ .0026	1.0	− .684	+376	− .0007	− .01
7777	+ .0016	1.0	− .684	+376	+ .0003	+ .01
7962	+ .0022	1.0	− .900	+402	− .0002	.00
7963	+0.0016	1.0	−0.900	+402	+0.0004	+0.01

The normal equations are:

$$22.5c + 1.466\mu - 5.1140\pi = -0.1082 \text{ mm.}$$
$$+ 229.0845\mu + 21.4809\pi = +0.5220 \text{ mm.}$$
$$+ 14.1189\pi = +0.0992 \text{ mm.}$$

from which:

$c = -0.00444$ mm.

$\mu = +0.00210$ mm. $= +0''.0436$, or $+0''.159$ per year.

$\pi = +0.00223$ mm. $= +\mathbf{0''.046 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00116 \text{ mm.} = \pm 0''.024.$$

α CEPHEI ($21^h\ 16^m$; $+62°\ 9'$)

Pritchard has investigated the parallax of this star by photography. Using four different comparison stars he determined parallaxes of $+0''.073$, $+0''.037$, $+0''.017$, and $+0''.119$, respectively, the probable errors averaging $\pm 0''.027$. Flint, by the meridian circle has found the parallax of $+0''.084 \pm 0''.024$. The star is of magnitude 2.60, of type A5, and of annual proper motion $0''.16$. Mr. Olivier measured the McCormick plates, and found a proper motion in right ascension of $+0''.154$ while the value from Boss is $+0''.152$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−29.3	−40.9	+0.2830
2	.13	−25.7	+29.0	.2921
3	.18	+19.0	+22.1	.2277
4	.26	+36.0	−10.2	+0.1972
Parallax star	0.27	− 4.4	− 0.1	

TABLE 1

PLATES OF α CEPHEI

No.	Date.	Hour Angle.	Observers.	Weight.
283	1914 Sept. 21	−0h2	M	0.9
310	Sept. 25	−0.4	Ol, G	0.7
316	Sept. 26	−0.3	M, A	0.9
490	Nov. 4	0.0	M	1.0
507	Nov. 5	−0.2	M	0.7
518	Nov. 6	−0.2	M	0.9
1399	1915 June 26	−0.9	G	0.7
1411	June 28	−0.9	G	0.6
1412	June 28	−0.5	G	1.0
1881	Oct. 28	−0.8	Ol	1.0
1882	Oct. 28	−0.4	Ol	0.6
1900	Oct. 29	−0.4	Ol	0.8
2691	1916 May 31	−0.9	Ol	0.8
2747	June 21	−1.0	Ol	1.0
2748	June 21	−0.6	Ol	0.9
2766	June 23	−0.7	Ol	0.9
2767	June 23	−0.3	Ol	0.7
3066	Sept. 23	−0.6	A	0.9
3067	Sept. 23	−0.2	A	0.9
3158	Oct. 8	−0.7	L	1.0
3159	Oct. 8	−0.3	L	1.0
3321	Nov. 1	−0.3	Ol	0.9
4066	1917 June 13	−0.4	Ol	0.9
4067	June 13	−0.1	Ol	0.9
4118	June 23	−1.0	Ol	0.9
4119	June 23	−0.7	Ol	1.0

The normal equations are:

$$22.5c + 3.409\mu - 2.7444\pi = +0.2238 \text{ mm.}$$
$$+ 258.4106\mu + 27.1429\pi = +0.6788 \text{ mm.}$$
$$+ 13.6061\pi = +0.0867 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR α CEPHEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
283	−0.0025	0.9	−0.635	−504	−0.0004	−0″.01
310	− .0030	0.7	− .681	−500	.0000	.00
316	− .0002	0.9	− .692	−499	− .0028	− .06
490	− .0064	1.0	− .942	−460	+ .0031	+ .06
507	− .0041	0.7	− .943	−459	+ .0008	+ .01
518	− .0016	0.9	− .944	−458	− .0017	− .03
1399	+ .0074	0.7	+ .650	−226	+ .0010	+ .02
1411	+ .0055	0.6	+ .626	−224	+ .0028	+ .05
1412	+ .0102	1.0	+ .626	−224	− .0019	− .04
1881	+ .0028	1.0	− .926	−102	+ .0013	+ .03
1882	+ .0058	0.6	− .926	−102	− .0017	− .03
1900	+ .0007	0.8	− .933	−101	+ .0033	+ .06
2691	+ .0156	0.8	+ .886	+114	+ .0008	+ .01
2747	+ .0175	1.0	+ .699	+135	− .0015	− .03
2748	+ .0175	0.9	+ .699	+135	− .0015	− .03
2766	+ .0164	0.9	+ .676	+137	− .0005	− .01
2767	+ .0145	0.7	+ .676	+137	+ .0014	+ .02
3066	+ .0118	0.9	− .665	+229	+ .0001	.00
3067	+ .0154	0.9	− .665	+229	− .0035	− .07
3158	+ .0120	1.0	− .814	+244	− .0004	− .01
3159	+ .0104	1.0	− .814	+244	+ .0012	+ .02
3321	+ .0123	0.9	− .939	+268	− .0008	− .01
4066	+ .0222	0.9	+ .784	+492	+ .0014	+ .03
4067	+ .0231	0.9	+ .784	+492	+ .0005	+ .01
4118	+ .0206	0.9	+ .679	+502	+ .0028	+ .05
4119	+0.0256	1.0	+0.679	+502	−0.0022	−0.05

from which:

$c = +0.01017$ mm.

$\mu = +0.00203$ mm. $= +0''.0423$, or $+0''.154$ per year.

$\pi = +0.00437$ mm. $= +\mathbf{0''.091} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

β AQUARII ($21^h\ 26^m$; $-6°\ 0'$)

This is a G-type star of magnitude 3.07 and of small annual proper motion, 0".016. Two faint stars are noted in Burnham's General Catalogue 11026, which are "not likely to have any connection with the large star." Mr. Briggs measured the majority of the McCormick plates, Mr. Mitchell measured a dozen of the plates, while some of the earlier ones were measured

TABLE 1

PLATES OF β AQUARII

No.	Date.	Hour Angle.	Observers.	Weight.
1747	1915 Sept. 23	$+0^h6$	G	0.5
3135	1916 Oct. 5	−0.2	L	1.0
3159	Oct. 10	+0.2	M	1.0
3160	Oct. 10	+0.6	M	1.0
4123	1917 June 24	−0.2	M	0.7*
4124	June 24	+0.2	M	0.7*
4176	July 19	−0.5	Ol	0.8
4177	July 19	0.0	Ol	0.8
4195	July 29	+0.1	Ol	0.7
4196	July 29	+0.6	Ol	0.7
4485	Sept. 29	+0.9	Ds, B	1.0
4678	Nov. 2	+0.6	B	1.0
4679	Nov. 2	+1.0	B	1.0
4791	Nov. 19	+0.3	M	1.0
4792	Nov. 19	+0.8	M	0.7
5538	1918 July 10	+0.4	A	0.7
5539	July 10	+0.7	A	1.0
5567	July 20	0.0	A	1.0
5568	July 20	+0.6	A	1.0
5740	Oct. 1	+0.6	M	1.0
5741	Oct. 1	+1.0	M	1.0
5748	Oct. 2	+0.4	M	1.0
5749	Oct. 2	+0.9	M	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR β AQUARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1747	−0.0107	0.5	−0.620	−760	+0.0031	+0″.05
3135	− .0058	1.0	− .759	−382	− .0015	− .03
3159	− .0098	1.0	− .804	−377	+ .0025	+ .05
3160	− .0069	1.0	− .804	−377	− .0004	− .01
4123	− .0087	0.7	+ .697	−120	+ .0014	+ .02
4124	− .0066	0.7	+ .697	−120	− .0006	− .01
4176	− .0056	0.8	+ .369	− 95	− .0016	− .03
4177	− .0105	0.8	+ .369	− 95	+ .0033	+ .06
4195	− .0073	0.7	+ .215	− 85	+ .0001	.00
4196	− .0078	0.7	+ .215	− 85	+ .0006	+ .01
4485	− .0044	1.0	− .695	− 23	− .0027	− .06
4678	− .0040	1.0	− .929	+ 11	− .0031	− .06
4679	− .0038	1.0	− .929	+ 11	− .0033	− .07
4791	− .0053	1.0	− .930	+ 28	− .0018	− .04
4792	− .0107	0.7	− .930	+ 28	+ .0036	+ .06
5538	− .0036	0.7	+ .500	+261	− .0034	− .06
5539	− .0074	1.0	+ .500	+261	+ .0004	+ .01
5567	− .0067	1.0	+ .357	+271	− .0003	− .01
5568	− .0059	1.0	+ .357	+271	− .0011	− .02
5740	− .0088	1.0	− .714	+344	+ .0019	+ .04
5741	− .0060	1.0	− .714	+344	− .0009	− .02
5748	− .0112	1.0	− .724	+345	+ .0043	+ .09
5749	−0.0085	1.0	−0.724	+345	+0.0016	+0.03

in addition by Mr. Lamb. The proper motion from the plates is + 0″.005 in right ascension, while the corresponding value from Boss amounts to + 0″.014. The only parallax determinations are by Flint with the result − 0″.068 ± 0″.032, and the spectroscopic value + 0″.018.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−62.7	+17.8	+0.2532
2	.10	+ 0.4	−31.5	.1773
3	.12	+ 4.9	−20.0	.1825
4	.12	+23.3	+42.0	.2150
5	.10	+34.1	− 8.3	+0.1720
Parallax star	0.14	− 4.0	+ 2.9	

The normal equations are:

$$20.3c + 4.553\mu - 6.2558\pi = -0.1440 \text{ mm.}$$
$$+ 150.3210\mu + 3.0882\pi = -0.0225 \text{ mm.}$$
$$+ 9.4511\pi = +0.0442 \text{ mm.}$$

from which:

$c = -0.00713$ mm.

$\mu = +0.00007$ mm. $= +0''.0014$, or $+0''.005$ per year.

$\pi = -0.00006$ mm. $= -\mathbf{0''.001 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00152 \text{ mm.} = \pm 0''.032.$$

γ CAPRICORNI ($21^h\ 34^m$; $-17°\ 6'$)

The spectroscopic parallax for this star which is of magnitude 3.80 and type Fp, and of annual proper motion 0″.19 is + 0″.035. Mr. Olivier measured the McCormick plates, and found a proper motion in right ascension of + 0″.169 while the proper motion from Boss is + 0″.187.

TABLE 1

PLATES OF γ CAPRICORNI

No.	Date.	Hour Angle.	Observers.	Weight.
357	1914 Sept. 30	+0^{h}4	M, G	0.8
539	Nov. 10	+0.3	Ol	1.0
1501	1915 July 23	−0.5	G	0.7
1512	July 24	+0.3	A	0.8
1513	July 24	+0.8	A	0.7
2004	Nov. 10	+1.1	Ol	0.9
2015	Nov. 16	−0.2	Ol	0.6
2030	Nov. 17	+0.5	Ol	0.8
2031	Nov. 17	+1.2	A	1.0
2732	1916 June 18	−1.2	Ol	0.6
2733	June 18	−0.6	Ol	1.1*
2749	June 21	−0.4	Ol	0.7
2750	June 21	+0.1	Ol	0.5
2768	June 23	0.0	Ol	0.9
2811	July 11	−0.5	L	0.7

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−26.4	+17.9	+0.2915
2	.17	−16.7	+14.3	.2402
3	.11	− 2.4	+27.1	.0573
4	.25	+25.9	−38.3	.2332
5	.16	+19.6	−21.0	+0.1778
Parallax star	0.20	− 2.3	− 2.5	

TABLE 2

REDUCTIONS FOR γ CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
357	−0.0147	0.8	−0.676	−425	−0.0002	0″.00
539	− .0134	1.0	− .935	−384	− .0008	− .02
1501	− .0078	0.7	+ .349	−129	+ .0001	.00
1512	− .0098	0.8	+ .333	−128	+ .0021	+ .04
1513	− .0076	0.7	+ .333	−128	− .0001	.00
2004	− .0054	0.9	− .935	− 19	− .0007	− .01
2015	− .0042	0.6	− .936	− 13	− .0018	− .03
2030	− .0081	0.8	− .935	− 12	+ .0021	+ .04
2031	− .0064	1.0	− .935	− 12	+ .0004	+ .01
2732	− .0006	0.6	+ .777	+202	+ .0005	+ .01
2733	− .0001	1.1	+ .777	+202	.0000	.00
2749	− .0002	0.7	+ .748	+205	+ .0001	.00
2750	+ .0031	0.5	+ .748	+205	− .0032	− .04
2768	+ .0010	0.9	+ .727	+207	− .0010	− .02
2811	−0.0013	0.7	+0.510	+225	+0.0015	+0.03

The normal equations are:

$$11.8c - 1.196\mu - 0.5883\pi = - 0.0631 \text{ mm.}$$
$$+ 52.2665\mu + 12.0351\pi = + 0.1299 \text{ mm.}$$
$$+ 6.7330\pi = + 0.0340 \text{ mm.}$$

from which:

$c = - 0.00509$ mm.

$\mu = + 0.00222$ mm. $= + 0''.0462$, or $+ 0''.169$ per year.

$\pi = + 0.00064$ mm. $= + \mathbf{0''.013 \pm 0''.009}$.

Probable error of plate of unit weight

$$= \pm 0.00083 \text{ mm.} = \pm 0''.017.$$

76 CYGNI ($21^h\ 37^m$; $+40°\ 21'$)

No parallax has been published for this star which is of A type and magnitude 6.05, with small proper motion 0″.05, but on the

assumption that it forms a member of an extended Ursa Major group, Bottlinger (*Astronomische Nachrichten*, **4738**), finds a theoretical parallax of + 0″.013. Mr. Alden measured the McCormick plates, except the last eight plates which were measured by Mr. Mitchell and found a relative parallax of + 0″.005 with a proper motion in right ascension of − 0″.030 while the value from Boss is − 0″.010.

TABLE 1

PLATES OF 76 CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
508	1914 Nov. 5	0ʰ0	M	1.0
549	Nov. 11	−0.1	M	0.6*
1396	1915 June 25	−0.1	A	0.9
1735	Sept. 22	−0.2	A	0.9
1945	Nov. 2	−0.4	M	1.0
1946	Nov. 2	0.0	A	0.7
2791	1916 July 3	−1.0	M	1.0
2792	July 3	−0.6	M	1.0
2793	July 3	−0.3	M	1.0
3144	Oct. 7	−0.3	A	1.0
3145	Oct. 7	0.0	A	0.9
3181	Oct. 12	−0.2	A	0.9
3182	Oct. 12	0.0	A	0.7*
3300	Oct. 28	−0.3	Ol, A	0.8
5510	1918 July 2	−0.1	A	1.0
5532	July 9	−1.3	Ol	0.7
5533	July 9	−0.9	Ol	0.9
5537	July 10	−0.3	A	0.9
5734	Sept. 30	−0.2	M	0.8
5739	Oct. 1	−0.4	M	1.0
5764	Oct. 6	−0.5	M	0.9
5765	Oct. 6	−0.1	M	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−71.9	−26.3	+0.2026
2	.13	−13.3	+45.5	.2276
3	.17	+ 7.1	−45.0	.1740
4	.19	+30.4	+45.8	.2177
5	.12	+47.7	−20.0	+0.1781
Parallax star	0.14	− 1.2	+ 3.6	

TABLE 2

REDUCTIONS FOR 76 CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
508	−0.0016	1.0	−0.925	−802	+0.0010	+0″.02
549	− .0028	0.6	− .934	−796	+ .0022	+ .04
1396	− .0030	0.9	+ .721	−570	+ .0019	+ .04
1735	− .0046	0.9	− .568	−481	+ .0028	+ .06
1945	− .0012	1.0	− .915	−471	− .0007	− .01
1946	− .0060	0.7	− .915	−471	+ .0041	+ .07
2791	− .0026	1.0	+ .621	−196	.0000	.00
2792	− .0002	1.0	+ .621	−196	− .0024	− .05
2793	− .0020	1.0	+ .621	−196	− .0006	− .01
3144	− .0035	1.0	− .747	−102	+ .0002	.00
3145	+ .0011	0.9	− .747	−102	− .0044	− .09
3181	− .0011	0.9	− .793	− 95	− .0022	− .04
3182	− .0004	0.7	− .793	− 95	− .0029	− .05
3300	+ .0009	0.8	− .898	− 79	− .0043	− .08
5510	− .0043	1.0	+ .639	+533	− .0011	− .02
5532	− .0086	0.7	+ .552	+540	+ .0031	+ .05
5533	− .0018	0.9	+ .552	+540	− .0037	− .07
5537	− .0090	0.9	+ .538	+541	+ .0035	+ .07
5734	− .0078	0.8	− .668	+623	+ .0017	+ .03
5739	− .0080	1.0	− .679	+624	+ .0019	+ .04
5764	− .0087	0.9	− .732	+629	+ .0026	+ .05
5765	−0.0052	0.9	−0.732	+629	−0.0009	−0.02

The normal equations are:

$$\begin{aligned} 19.5c + 1.153\mu - 4.9713\pi &= -0.0702 \text{ mm.} \\ + 448.1682\mu + 12.4756\pi &= -0.1759 \text{ mm.} \\ + 10.3678\pi &= +0.0151 \text{ mm.} \end{aligned}$$

from which:

$c = -0.00351$ mm.
$\mu = -0.00039$ mm. $= -0''.0081$, or $-0''.030$ per year.
$\pi = +0.00024$ mm. $= +\mathbf{0''.005 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00169 \text{ mm.} = \pm 0''.035.$$

ϵ PEGASI ($21^h\ 39^m$; $+9°\ 25'$)

This is a star of Ko type, and of magnitude 2.54, with small proper motion $0''.025$. Pritchard, by photography, determined the parallax with the result, $+ 0''.080 \pm 0''.015$, while Flint with the meridian circle obtained the relative parallax $+ 0''.041 \pm 0''.030$, and the Allegheny Observatory by photography the value $- 0''.022 \pm 0''.009$. Adams by the spectrograph gives the absolute parallax $+ 0''.028$. The McCormick plates were measured by Mr. Olivier who obtained the relative parallax of $+ 0''.017 \pm 0''.008$, and a proper motion in right ascension of $+ 0''.022$ while the corresponding value from Boss is $+ 0''.025$.

TABLE 1

PLATES OF ϵ PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
1452	1915 July 9	+0h1	G	0.9
1494	July 18	0.0	A	0.8
1495	July 18	+0.5	A	0.7
1518	Aug. 2	−0.2	Ol	0.7
1519	Aug. 2	+0.8	Ol, L	0.7
1723	Sept. 19	+0.8	M	0.9
1976	Nov. 7	+0.4	M	0.6
2799	1916 July 5	−0.7	L	0.6
2800	July 5	−0.2	L	0.6
3136	Oct. 5	+0.1	L	0.8
3137	Oct. 5	+0.6	L	0.8
3191	Oct. 14	−0.5	L	0.8
3192	Oct. 14	0.0	L	0.6
3280	Oct. 26	−0.3	A	0.7
4146	1917 June 30	−0.3	Ol	0.7
4147	June 30	+0.1	Ol	0.6
4202	July 30	+0.2	A	1.0
4203	July 30	+0.6	A	1.0
4539	Oct. 7	+0.4	M	0.9
4540	Oct. 7	+0.8	M	0.9
4580	Oct. 15	+0.3	D	0.8
4581	Oct. 15	+0.8	D	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−30.2	+ 7.7	+0.1347
2	.24	+ 2.6	−42.3	.2428
3	.17	+ 9.3	+28.8	.2984
4	.20	+18.3	+ 5.8	+0.3241
Parallax star	0.23	+ 5.3	+ 1.2	

TABLE 2

REDUCTIONS FOR ϵ PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
1452	+0.0009	0.9	+0.561	−434	+0.0021	+0″.04
1494	+ .0032	0.8	+ .438	−425	− .0003	− .01
1495	+ .0039	0.7	+ .438	−425	− .0010	− .02
1518	+ .0038	0.7	+ .213	−410	− .0010	− .02
1519	+ .0059	0.7	+ .213	−410	− .0031	− .05
1723	+ .0011	0.9	− .523	−362	+ .0012	+ .02
1976	+ .0009	0.6	− .927	−313	+ .0012	+ .02
2799	+ .0028	0.6	+ .602	− 72	+ .0013	+ .02
2800	+ .0008	0.6	+ .602	− 72	+ .0033	+ .05
3136	+ .0049	0.8	− .722	+ 20	− .0016	− .03
3137	+ .0061	0.8	− .722	+ 20	− .0028	− .05
3191	+ .0036	0.8	− .805	+ 29	− .0004	− .01
3192	+ .0030	0.6	− .805	+ 29	+ .0002	.00
3280	+ .0011	0.7	− .886	+ 41	+ .0021	+ .04
4146	+ .0055	0.7	+ .665	+288	− .0003	− .01
4147	+ .0078	0.6	+ .665	+288	− .0026	− .04
4202	+ .0046	1.0	+ .252	+318	+ .0003	+ .01
4203	+ .0047	1.0	+ .252	+318	+ .0002	.00
4539	+ .0034	0.9	− .740	+387	+ .0009	+ .02
4540	+ .0044	0.9	− .740	+387	− .0001	.00
4580	+ .0035	0.8	− .812	+395	+ .0008	+ .01
4581	+0.0045	0.9	−0.812	+395	−0.0002	0.00

The normal equations are:

$$17.0c + 2.777\mu - 3.0907\pi = + 0.0625 \text{ mm.}$$
$$+ 170.6636\mu - 10.6085\pi = + 0.0511 \text{ mm.}$$
$$+ 6.9304\pi = - 0.0090 \text{ mm.}$$

from which:

$c = + 0.00378$ mm.

$\mu = + 0.00029$ mm. $= + 0''.0060$, or $+ 0''.022$ per year.

$\pi = + 0.00082$ mm. $= + \mathbf{0''.017 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00097 \text{ mm.} = \pm 0''.020.$$

μ CYGNI ($21^h\ 39^m$; $+28^\circ\ 17'$)

This is a double star, Σ 2822, and according to Burnham their relative motions finds the simplest explanation under the assumption that they form a system of the 61 Cygni class, with slightly different proper motions. The brighter star is of 4.73 magnitude, and F5 type, and the fainter of 6.0 magnitude. The rotating sector was utilized to reduce the brightness of the parallax star,

TABLE 1

PLATES OF μ CYGNI

No.	Date.	Hour Angle.	Observers.	Weight.
317	1914 Sept. 26	−0h2	M, A	0.7
406	Oct. 18	+0.1	M	1.0
462	Nov. 1	−0.2	M	1.0
468	Nov. 2	−0.1	G	1.0
594	Nov. 20	−0.2	Ol	0.9
598	Nov. 21	0.0	M	1.0
611	Nov. 22	0.0	M	1.0
1383	1915 June 22	−0.6	G	0.9
1401	June 26	−0.4	G	0.7
1402	June 26	0.0	G	0.7
1420	June 30	−0.4	G	1.0
1839	Oct. 24	−0.2	M	0.8
1840	Oct. 24	+0.1	M	1.0
1883	Oct. 28	−0.3	M	1.0
1884	Oct. 28	0.0	M	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.18	−73.2	− 6.0	+0.300
2	.27	+ 0.4	+ 6.0	.279
3	.15	+22.0	+ 3.5	.243
4	.17	+50.8	− 3.5	+0.178
Parallax star	0.18	− 7.5	+ 0.1	

with the result that the brighter star only was measured. Mr. Mitchell measured the plates, and found a proper motion in right ascension to be + 0″.330 while the value from Boss is + 0″.283. The spectroscopic parallax is +0″.058.

TABLE 2

REDUCTIONS FOR μ CYGNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
317	−0.0645	0.7	−0.613	−269	−0.0001	0″.00
406	− .0624	1.0	− .831	−247	− .0017	− .03
462	− .0646	1.0	− .909	−233	+ .0010	+ .02
468	− .0642	1.0	− .913	−232	+ .0006	+ .02
594	− .0632	0.9	− .930	−214	+ .0003	+ .01
598	− .0626	1.0	− .928	−213	− .0002	− .01
611	− .0628	1.0	− .926	−212	+ .0001	.00
1383	− .0508	0.9	+ .757	0	+ .0005	+ .01
1401	− .0528	0.7	+ .716	+ 4	+ .0019	+ .04
1402	− .0483	0.7	+ .716	+ 4	− .0013	− .03
1420	− .0491	1.0	+ .672	+ 8	− .0008	− .02
1839	− .0446	0.8	− .870	+124	− .0029	− .06
1840	− .0460	1.0	− .870	+124	− .0020	− .04
1883	− .0512	1.0	− .891	+128	+ .0033	+ .07
1884	−0.0492	1.0	−0.891	+128	+0.0013	+0.03

The normal equations are:

$$13.7c - 10.251\mu - 6.7654\pi = -0.7663 \text{ mm.}$$
$$+ 41.1835\mu + 9.0450\pi = +0.7267 \text{ mm.}$$
$$+ 9.7457\pi = +0.4083 \text{ mm.}$$

from which:

$c = -0.05172$ mm.

$\mu = +0.00434$ mm. $= +0''.0903$, or $+0''.330$ per year.

$\pi = +0.00196$ mm. $= +$ **0″.041 ± 0″.010.**

Probable error of plate of unit weight

$$\pm 0.00123 \text{ mm.} = \pm 0''.026.$$

κ PEGASI ($21^h\ 40^m$; $+25°\ 11'$)

κ Pegasi is a star of more than ordinary interest. It is a visual binary discovered by Burnham in 1880, and having one of the shortest known periods of 11.37 years. According to Aitken, the magnitudes are 5.0 and 5.1. Campbell (*Astrophysical Journal*, **12**, 257, 1900) found that one of the components was a spectroscopic binary. κ Pegasi is, therefore, a triple system. In *Lick Observatory Bulletin*, **9**, 120, 1918, Henroteau makes a careful investigation of the spectroscopic orbit, findng a period of 5.9175 days. He finds a parallax of $+ 0''.025 \pm 0''.002$, and the masses of the visual binary to be 10.33 and 4.00 timcs that of the sun, while the masses of the spectroscopic binary are $6.62\odot$ and $3.71\odot$, respectively. The parallax has been found by other observers as follows:

Parallax.	Authority.	Method.
$-0''.02 \pm 0''.043$	Flint	Meridian Circle
$+ .084 \pm .071$	Jewdokimov	Meridian Circle
$+ .021 \pm .011$	Lee	Photography
$+ .073 \pm .009$	Miller and Steele	Photography
$+ .021 \pm .007$	Allegheny	Photography
$+0.036$	Adams	Spectrograph

Mr. Mitchell measured the McCormick series of plates, with the exception of the first four plates which were measured by Mr. Graham. He found a relative parallax of $+ 0''.016 \pm 0''.008$, with an annual proper motion in right ascension of $+ 0''.010$ while the value from Boss is $+ 0''.032$. The McCormick value of the absolute parallax is $+ 0''.021$, is in substantial agreement with the value found by Henroteau. Using this value of the parallax, and Burnham's orbit where $a = 0''.29$, the mass of the system is found to be 20.37 times that of the sun.

TABLE 1

PLATES OF κ PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
330	1914 Sept. 27	$-0^h.1$	M	0.9
476	Nov. 3	+0.2	M	1.0
519	Nov. 6	−0.1	M	1.0
636	Nov. 24	−0.1	M	0.9
1413	1915 June 28	−0.4	G	0.9
1414	June 28	0.0	G	0.7
1428	July 3	−0.7	G	0.8
1429	July 3	−0.3	G	0.8
1442	July 8	−0.3	G	0.5*
1829	Oct. 21	−0.8	G	0.8
1830	Oct. 21	−0.4	G	0.9
1975	Nov. 7	−0.3	M	0.8
3379	1916 Nov. 11	−0.4	M	1.0
3380	Nov. 11	−0.1	M	1.0
3382	Nov. 16	−0.1	M	1.0
4135	1917 June 29	−0.8	A	0.9
4136	June 29	−0.4	A	0.9
4156	July 1	−1.0	A	0.7
4157	July 1	−0.6	A	0.7
4537	Oct. 7	−0.3	M	1.0
4538	Oct. 7	0.0	M	1.0
4642	Oct. 28	0.0	M	1.0
4643	Oct. 28	+0.2	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.21	−58.3	−20.4	+0.2490
2	.15	−23.4	+17.9	.2482
3	.13	+17.4	−47.3	.2531
4	.18	+64.3	+49.8	+0.2497
Parallax star	0.18	+ 0.1	− 0.2	

TABLE 2

REDUCTIONS FOR κ PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
330	−0.0086	0.9	−0.624	−589	−0.0011	−0″.02
476	− .0096	1.0	− .916	−552	− .0002	.00
519	− .0084	1.0	− .924	−549	− .0014	− .03
636	− .0090	0.9	− .921	−531	− .0008	− .02
1413	− .0085	0.9	+ .696	−315	+ .0002	.00
1414	− .0079	0.7	+ .696	−315	− .0004	− .01
1428	− .0083	0.8	+ .639	−310	.0000	.00
1429	− .0092	0.8	+ .639	−310	+ .0009	+ .02
1442	− .0111	0.5	+ .577	−305	+ .0027	+ .04
1829	− .0118	0.8	− .850	−200	+ .0025	+ .05
1830	− .0099	0.9	− .850	−200	+ .0006	+ .01
1975	− .0087	0.8	− .926	−183	− .0006	− .01
3379	− .0092	1.0	− .933	+187	+ .0003	+ .01
3380	− .0107	1.0	− .933	+187	+ .0018	+ .04
3382	− .0090	1.0	− .934	+192	+ .0002	.00
4135	− .0067	0.9	+ .679	+417	− .0006	− .01
4136	− .0065	0.9	+ .679	+417	− .0008	− .02
4156	− .0116	0.7	+ .656	+419	+ .0043	+ .07
4157	− .0024	0.7	+ .656	+419	− .0049	− .09
4537	− .0113	1.0	− .737	+517	+ .0030	+ .06
4538	− .0058	1.0	− .737	+517	− .0025	− .05
4642	− .0076	1.0	− .893	+538	− .0008	− .02
4643	−0.0075	1.0	−0.893	+538	−0.0009	−0.02

The normal equations are:

$$20.2c + 2.653\mu - 6.9112\pi = -0.1747 \text{ mm.}$$
$$+ 340.4976\mu + 0.9595\pi = +0.0242 \text{ mm.}$$
$$+ 13.0427\pi = +0.0681 \text{ mm.}$$

from which:

$c = -0.00840$ mm.

$\mu = +0.00013$ mm. $= +0''.0028$, or $+0''.010$ per year.

$\pi = +0.00076$ mm. $= +\mathbf{0''.016 \pm 0''.008}$.

Probable error of plate unit weight

$$\pm 0.00121 \text{ mm.} = \pm 0''.025.$$

δ CAPRICORNI ($21^h\ 41^m$; $-16°\ 34'$)

The McCormick measures give a parallax for this star of $+ 0''.110 \pm 0''.012$. No other parallax has been determined. It is of A5 type, of magnitude 2.98, and of total proper motion $0''.392$. Slipher found it to be a spectroscopic binary (*Astrophysical Journal*, **24**, 361, 1906). Miss Hawes measured the plates, and found a proper motion in right ascension $+ 0''.262$, in good agreement with the value of Boss amounting to $+ 0''.258$.

TABLE 1

PLATES OF δ CAPRICORNI

No.	Date.	Hour Angle.	Observers.	Weight.
3095	1916 Sept. 26	$+0^h.2$	M	1.0
3168	Oct. 11	−0.2	L	1.0
3169	Oct. 11	+0.1	L	1.0
3252	Oct. 23	−0.4	L	1.0
3253	Oct. 23	−0.1	L	1.0
4224	1917 Aug. 1	+0.3	Ol	0.7
4225	Aug. 1	+0.6	Ol	0.7
4244	Aug. 5	+0.6	A	0.9
4245	Aug. 5	+0.9	A	1.0
4565	Oct. 13	+0.7	Ds	0.9
4741	Nov. 9	+0.4	Ol	1.0
4742	Nov. 9	+0.9	Ds	1.0
4797	Nov. 20	+0.1	Ol	1.0
4798	Nov. 20	+0.5	Ol	1.0
5544	1918 July 13	−0.3	Ol	0.7
5546	July 13	+0.7	Ol	0.8
5575	July 21	−0.5	A	1.0
5735	Sept. 30	+0.1	M	1.0
5736	Sept. 30	+0.5	M	1.0
5771	Oct. 8	−0.2	H, D	0.8
5772	Oct. 8	+0.2	M, D	1.0
7225	June 22	−0.7	Ol	0.9
7280	July 4	−0.1	Ol	0.9
7281	July 4	+0.4	Ol	1.0
7282	July 4	+0.9	Ol	1.0
7291	July 5	−0.5	D	1.0

TABLE 2

REDUCTIONS FOR δ CAPRICORNI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3095	−0.0632	1.0	−0.613	−395	−0.0052	−0″.10
3168	− .0664	1.0	− .773	−380	− .0023	− .05
3169	− .0702	1.0	− .773	−380	+ .0015	+ .03
3252	− .0722	1.0	− .864	−368	+ .0034	+ .07
3253	− .0676	1.0	− .864	−368	− .0012	− .02
4224	− .0517	0.7	+ .230	− 86	− .0015	− .03
4225	− .0516	0.7	+ .230	− 86	− .0016	− .03
4244	− .0547	0.9	+ .168	− 82	+ .0013	+ .02
4245	− .0524	1.0	+ .168	− 82	− .0010	− .02
4565	− .0571	0.9	− .789	− 13	+ .0010	+ .02
4741	− .0562	1.0	− .930	+ 14	+ .0003	+ .01
4742	− .0576	1.0	− .930	+ 14	+ .0017	+ .04
4797	− .0590	1.0	− .930	+ 25	+ .0034	+ .07
4798	− .0562	1.0	− .930	+ 25	+ .0006	+ .01
5544	− .0410	0.7	+ .512	+260	+ .0012	+ .02
5546	− .0411	0.8	+ .512	+260	+ .0013	+ .02
5575	− .0458	1.0	+ .401	+268	+ .0056	+ .12
5735	− .0407	1.0	− .655	+339	− .0026	− .05
5736	− .0418	1.0	− .655	+339	− .0015	− .03
5771	− .0421	0.8	− .740	+347	− .0014	− .02
5772	− .0430	1.0	− .740	+347	− .0005	− .01
7225	− .0260	0.9	+ .762	+604	− .0007	− .01
7280	− .0278	0.9	+ .643	+616	+ .0009	+ .02
7281	− .0264	1.0	+ .643	+616	− .0005	− .01
7282	− .0250	1.0	+ .643	+616	− .0019	− .04
7291	−0.0261	1.0	+0.619	+617	−0.0009	−0.02

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.08	−38.7	+31.1	+0.211
2	.16	−31.7	+21.1	.210
3	.10	+18.4	−52.0	.204
4	.08	+22.2	+50.8	.177
5	.10	+29.8	−51.0	+0.198
Parallax star	0.10	− 1.28	− 0.70	

The normal equations are:

$$24.3c + 28.067\mu - 5.9794\pi = - 1.1864 \text{ mm.}$$
$$+ 316.9845\mu + 26.9400\pi = - 0.2111 \text{ mm.}$$
$$+ 11.7139\pi = + 0.4627 \text{ mm.}$$

from which:

$c = - 0.05150$ mm.

$\mu = + 0.00344$ mm. $= + 0''.0716$, or $+ 0''.262$ per year.

$\pi = + 0.00529$ mm. $= + \mathbf{0''.110 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00145 \text{ mm.} = \pm 0''.030.$$

α AQUARII ($22^h\ 0^m$; $-0°\ 48'$)

The only parallax published is the absolute value of Adams by the spectrograph with the result $+ 0''.004$. The star is of 3.19 magnitude, of Go type, and of small proper motion $0''.015$. Mr. Mitchell measured the McCormick plates with the exception of four photographs measured by Mr. Graham. The proper motion in right ascension from the plates is $+ 0''.002$ while the value from Boss is $+ 0''.014$.

TABLE 1

PLATES OF α AQUARII

No.	Date.	Hour Angls.	Observers.	Weight.
331	1914 Sept. 27	$+0^h.9$	M	0.5
332	Sept. 27	+1.4	M	0.7
527	Nov. 9	+0.5	Ol	0.8
591	Nov. 19	+0.9	A	1.0
1443	1915 July 8	−0.1	G	0.6
1444	July 8	$+0.\tilde{5}$	G	0.5
1473	July 16	−0.3	G	0.5
1474	July 16	+0.2	G	0.5
1857	Oct. 25	+0.6	G	0.5
1858	Oct. 25	+1.1	G	0.7
2051	Nov. 24	0.0	Ol	0.7
2061	Nov. 25	−0.1	M	1.0
2834	1916 July 29	0.0	A	0.8
2835	July 29	+0.6	A	0.8
2843	Aug. 4	+0.9	A	0.9
2844	Aug. 4	+1.4	A	0.7
3170	Oct. 11	+0.4	L	1.0
3171	Oct. 11	+0.8	L	1.0
3329	Nov. 2	−0.1	L	1.0
3330	Nov. 2	+0.2	L	0.9

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−42.7	+40.9	+0.194
2	.21	−15.7	+23.1	.202
3	.15	+21.1	−50.7	.382
4	.15	+37.3	−13.3	+0.222
Parallax star	0.20	+ 4.9	− 9.7	

The normal equations are:

$$15.1c + 9.371\mu - 5.7883\pi = +0.3256 \text{ mm.}$$
$$+122.2508\mu - 1.3745\pi = +0.2053 \text{ mm.}$$
$$+7.7394\pi = -0.1234 \text{ mm.}$$

TABLE 2

REDUCTIONS FOR α AQUARII

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
331	+0.0176	0.5	−0.552	−397	+0.0038	+0″.05
332	+ .0191	0.7	− .552	−397	+ .0023	+ .04
527	+ .0227	0.8	− .910	−385	− .0014	− .02
591	+ .0228	1.0	− .927	−375	− .0015	− .03
1443	+ .0245	0.6	+ .641	−113	− .0027	− .04
1444	+ .0246	0.5	+ .641	−113	− .0028	− .04
1473	+ .0193	0.5	+ .542	−105	+ .0025	+ .03
1474	+ .0226	0.5	+ .542	−105	− .0008	− .01
1857	+ .0214	0.5	− .833	− 4	.0000	.00
1858	+ .0180	0.7	− .833	− 4	+ .0034	+ .06
2051	+ .0230	0.7	− .923	+ 26	− .0016	− .03
2061	+ .0226	1.0	− .924	+ 27	− .0012	− .02
2834	+ .0214	0.8	+ .349	+274	+ .0004	+ .01
2835	+ .0205	0.8	+ .349	+274	+ .0013	+ .02
2843	+ .0204	0.9	+ .258	+280	+ .0014	+ .03
2844	+ .0235	0.7	+ .258	+280	− .0017	− .03
3170	+ .0194	1.0	− .719	+348	+ .0021	+ .04
3171	+ .0219	1.0	− .719	+348	− .0004	− .01
3329	+ .0216	1.0	− .885	+370	− .0001	.00
3330	+0.0237	0.9	−0.885	+370	−0.0022	−0.04

from which:

$c = +0.02165$ mm.

$\mu = +0.00002$ mm. $= +0''.0005$, or $+0''.002$ per year.

$\pi = +0.00025$ mm. $= +\mathbf{0''.005 \pm 0''.010}$.

Probable error of plate of unit weight

± 0.00118 mm. $= \pm 0''.024$.

ν PEGASI ($22^h\ 0^m$; $+4°\ 34'$)

The Allegheny parallax by photography is $+0''.010 \pm 0''.009$, while the spectroscopic value is $+0''.012$. The star is of magnitude 4.90, of type Kp, and of total proper motion $0''.138$. Miss Darkow measured the McCormick plates finding a relative

parallax of $+ 0''.012 \pm 0''.008$, and a proper motion in right ascension $+ 0''.090$, while the corresponding value from Boss is $+ 0''.103$.

TABLE 1

PLATES OF 22 PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
3301	1916 Oct. 28	$+0^h.1$	Ol	1.0
3341	Nov. 3	−0.2	L	0.9
3342	Nov. 3	+0.1	L	1.0
3434	Nov. 24	−0.2	Ol	0.6
3435	Nov. 24	+0.2	Ol	0.9
4252	1917 Aug. 10	+0.3	A	1.0
4654	Oct. 31	+0.5	B	0.9
4655	Oct. 31	+0.9	B	0.9
4810	Nov. 26	+0.1	M	1.0
4811	Nov. 26	+0.4	M	0.8
5556	1918 July 14	−0.3	A	1.0
5557	July 14	0.0	A	0.8
5576	July 21	−0.3	A	1.0
5577	July 21	+0.2	A	1.0
5596	Aug. 5	−0.7	A	0.7
5773	Oct. 8	+0.3	H, D	0.9
5780	Oct. 9	+0.2	F	0.8
5817	Oct. 16	+0.4	M	0.8
5818	Oct. 16	+0.8	M	0.7

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.09	−39.6	−27.1	+0.186
2	.13	−33.8	+31.4	.161
3	.13	+ 4.5	+31.9	.188
4	.21	+11.6	−35.3	.225
5	.14	+57.3	− 0.9	+0.240
Parallax star	0.16	+ 4.4	− 2.2	

TABLE 2

REDUCTIONS FOR 22 PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3301	−0.0331	1.0	−0.858	−415	+0.0011	+0″.02
3341	− .0308	0.9	− .890	−409	− .0012	− .02
3342	− .0314	1.0	− .890	−409	− .0006	− .01
3434	− .0290	0.6	− .924	−388	− .0027	− .04
3435	− .0332	0.9	− .924	−388	+ .0015	+ .03
4252	− .0294	1.0	+ .168	−129	+ .0014	+ .03
4654	− .0278	0.9	− .874	− 47	+ .0002	.00
4655	− .0285	0.9	− .874	− 47	+ .0008	+ .02
4810	− .0276	1.0	− .921	− 21	+ .0002	.00
4811	− .0259	0.8	− .921	− 21	− .0015	− .03
5556	− .0234	1.0	+ .563	+209	− .0004	− .01
5557	− .0238	0.8	+ .563	+209	.0000	.00
5576	− .0214	1.0	+ .470	+216	− .0023	− .05
5577	− .0236	1.0	+ .470	+216	− .0001	.00
5596	− .0265	0.7	+ .250	+231	+ .0028	+ .05
5773	− .0230	0.9	− .683	+295	− .0005	− .01
5780	− .0234	0.8	− .694	+296	− .0001	.00
5817	− .0232	0.8	− .763	+303	− .0002	.00
5818	−0.0246	0.7	−0.763	+303	+0.0012	+0.02

The normal equations are:

$$16.7c - 0.988\mu - 7.1840\pi = -0.4491 \text{ mm.}$$
$$+ 123.2705\mu + 14.3535\pi = +0.1809 \text{ mm.}$$
$$+ 9.1863\pi = +0.2133 \text{ mm.}$$

from which:

$c = -0.02657$ mm.

$\mu = +0.00119$ mm. $= +0''.0247$, or $+0''.090$ per year.

$\pi = +0.00059$ mm. $= +\mathbf{0''.012 \pm 0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00086 \text{ mm.} = \pm 0''.018.$$

ι PEGASI ($22^h\ 2^m$; $+24°\ 51'$)

This star is of 3.95 magnitude, of type F5, and of annual proper motion 0″.30. Its parallax has recently been determined by photography; Swarthmore Observatory obtained the relative

TABLE 1

PLATES OF ι PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
106	1914 June 28	0^h0	M, Ol	1.0
119	July 9	−1.1	M	0.9
120	July 9	−0.6	M	0.7
130	July 15	−0.1	Ol	1.0
383	Oct. 9	−0.4	Ol, G	0.7
449	Oct. 31	−0.2	A	0.7
463	Nov. 1	−0.1	M	1.0
469	Nov. 2	0.0	G	0.9
477	Nov. 3	+0.2	M	1.0
564	Nov. 12	−0.3	Ol	0.7
637	Nov. 24	0.0	M	0.8
1437	1915 July 6	−0.6	A	0.9
1438	July 6	−0.1	A	0.9
1538	Aug. 9	−0.3	L	0.9
1539	Aug. 9	+0.1	L	0.6*
3285	1916 Oct. 27	−0.4	L	0.6*
3322	Nov. 1	−0.4	A	1.0
3323	Nov. 1	−0.1	A	1.0
3382	Nov. 16	−0.1	M	0.9
4214	1917 July 31	−0.3	Ol	0.8
4215	July 31	0.0	Ol	1.0
4242	Aug. 5	−0.5	A	0.9
4243	Aug. 5	−0.2	A	0.9
4600	Oct. 20	−0.5	Ds	0.6*
4644	Oct. 30	−0.6	B	0.9
4645	Oct. 30	−0.2	B	0.8
4664	Nov. 1	−0.7	M	0.9
4665	Nov. 1	−0.3	A	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR ι PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
106	+0.0122	1.0	+0.750	−591	−0.0023	−0″.05
119	+ .0123	0.9	+ .631	−580	− .0025	− .05
120	+ .0107	0.7	+ .631	−580	− .0009	− .02
130	+ .0092	1.0	+ .556	−574	+ .0005	+ .01
383	+ .0066	0.7	− .688	−488	+ .0007	+ .01
449	+ .0062	0.7	− .870	−466	+ .0011	+ .02
463	+ .0090	1.0	− .875	−465	− .0016	− .03
469	+ .0054	0.9	− .880	−464	+ .0020	+ .04
477	+ .0064	1.0	− .885	−463	+ .0010	+ .02
564	+ .0042	0.7	− .917	−454	+ .0034	+ .06
637	+ .0092	0.8	− .924	−442	− .0012	− .02
1437	+ .0209	0.9	+ .668	−218	+ .0021	+ .04
1438	+ .0224	0.9	+ .668	−218	+ .0006	+ .01
1538	+ .0204	0.9	+ .199	−184	+ .0018	+ .04
1539	+ .0220	0.6	+ .199	−184	+ .0002	.00
3285	+ .0338	0.6	− .849	+256	− .0004	− .01
3322	+ .0381	1.0	− .878	+266	− .0045	− .09
3323	+ .0349	1.0	− .878	+266	− .0013	− .03
3382	+ .0332	0.9	− .924	+281	+ .0008	+ .01
4214	+ .0480	0.8	+ .328	+538	+ .0007	+ .01
4215	+ .0455	1.0	+ .328	+538	+ .0032	+ .07
4242	+ .0488	0.9	+ .253	+543	− .0003	.00
4243	+ .0508	0.9	+ .253	+543	− .0023	− .04
4600	+ .0475	0.6	− .795	+619	− .0008	− .01
4644	+ .0460	0.9	− .865	+629	+ .0007	+ .01
4645	+ .0494	0.8	− .865	+629	− .0027	− .05
4664	+ .0448	0.9	− .876	+631	+ .0020	+ .04
4665	+0.0458	1.0	−0.876	+631	+0.0010	+0.02

parallax + 0″.063 ± 0″.011, while Allegheny derived the result + 0″.067. Adams finds the absolute parallax by the spectrograph of + 0″.087. Mr. Olivier measured the McCormick series of plates. He derived the proper motion in right ascension + 0″.273 per year. The value of the proper motion according to Boss is + 0″.299.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	−41.6	− 4.0	+0.0456
2	.36	− 7.7	−26.2	.2265
3	.24	+14.5	−27.5	.3374
4	.26	+34.8	+57.7	+0.3905
Parallax star	0.27	+14.8	+ 7.1	

The normal equations are:

$$24.0c + 0.777\mu - 6.8703\pi = + 0.6422 \text{ mm.}$$
$$+ 555.9585\mu - 18.8064\pi = + 1.9387 \text{ mm.}$$
$$+ 12.9106\pi = - 0.2028 \text{ mm.}$$

from which:

$c = + 0.02790$ mm.

$\mu = + 0.00360$ mm. $= + 0''.0748$, or $+ 0''.273$ per year.

$\pi = + 0.00438$ mm. $= + \mathbf{0''.091} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00124 \text{ mm.} = \pm 0''.026.$$

ζ CEPHEI ($22^h\ 7^m$; $+57°\ 42'$)

This star of magnitude 3.62, of type K and of total proper motion 0″.013 has had its parallax determined by photography at the Allegheny Observatory with the value + 0″.023 ± 0″.010, and by Mt. Wilson by the spectrograph + 0″.024. Mr. Olivier measured the McCormick plates and derived the parallax + 0″.019 ± 0″.010 with the proper motion in right ascension + 0″.011 where the value from Boss is + 0″.011.

TABLE 1

PLATES OF ζ CEPHEI

No.	Date.	Hour Angle.	Observers.	Weight.
389	1914 Oct. 11	-0^h1	M	1.0
491	Nov. 4	−0.2	G	0.8
581	Nov. 17	−0.1	M	0.9
1936	1915 Nov. 1	−1.5	Ol	0.6
2042	Nov. 19	−0.9	Ol	0.7
2043	Nov. 19	−0.4	Ol	0.5
3431	1916 Nov. 22	−0.3	Ol	0.8
3432	Nov. 22	+0.1	Ol	1.0
5520	1918 July 3	−1.0	Ol	1.0
5521	July 3	−0.6	Ol	0.9
5534	July 9	−0.8	Ol	1.0
5535	July 9	−0.2	Ol	0.8
5816	Oct. 16	0.0	M	0.8
5841	Oct. 31	−0.4	M	1.0
5842	Oct. 31	0.0	M	0.8
5868	Nov. 3	−1.0	M	0.9
5869	Nov. 3	−0.6	M	0.9
7192	1919 June 8	−1.7	Ol	0.6
7193	June 8	−1.2	Ol	1.1*
7194	June 17	−1.8	Ol	1.0
7195	June 17	−1.5	Ol	1.0
7196	June 17	−1.1	Ol	1.0
7197	June 17	−0.6	Ol	1.0

* Three exposures.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−40.1	−35.3	+0.3983
2	.16	−26.4	+33.3	.2624
3	.20	+66.5	+ 2.0	+0.3393
Parallax star	0.20	− 0.3	− 4.6	

TABLE 2

REDUCTIONS FOR ζ CEPHEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
389	+0.0036	1.0	−0.694	−1126	−0.0012	−0″.02
491	+ .0009	0.8	− .882	−1102	+ .0014	+ .02
581	+ .0021	0.9	− .922	−1089	+ .0002	.00
1936	+ .0031	0.6	− .865	− 740	− .0003	.00
2042	+ .0051	0.7	− .923	− 722	− .0023	− .04
2043	+ .0052	0.5	− .923	− 722	− .0024	− .04
3431	+ .0011	0.8	− .924	− 353	+ .0022	+ .04
3432	+ .0021	1.0	− .924	− 353	+ .0012	+ .02
5520	+ .0051	1.0	+ .712	+ 235	+ .0005	+ .01
5521	+ .0038	0.9	+ .712	+ 235	+ .0018	+ .04
5534	+ .0024	1.0	+ .645	+ 241	+ .0032	+ .07
5535	+ .0073	0.8	+ .645	+ 241	− .0017	− .03
5816	+ .0043	0.8	− .745	+ 340	+ .0001	.00
5841	+ .0070	1.0	− .861	+ 355	− .0027	− .06
5842	+ .0067	0.8	− .861	+ 355	− .0024	− .04
5868	+ .0023	0.9	− .877	+ 358	+ .0020	+ .04
5869	+ .0020	0.9	− .877	+ 358	+ .0023	+ .05
7192	+ .0050	0.6	+ .906	+ 575	+ .0013	+ .02
7193	+ .0098	1.1	+ .906	+ 575	− .0035	− .08
7194	+ .0083	1.0	+ .854	+ 584	− .0021	− .04
7195	+ .0057	1.0	+ .854	+ 584	+ .0005	+ .01
7196	+ .0081	1.0	+ .854	+ 584	− .0019	− .04
7197	+0.0030	1.0	+0.854	+ 584	+0.0032	+0.07

The normal equations are:

$$20.1c + 8.157\mu - 1.7736\pi = + 0.0925 \text{ mm.}$$
$$+ 717.0905\mu + 63.9383\pi = + 0.1972 \text{ mm.}$$
$$+ 14.0647\pi = + 0.0138 \text{ mm.}$$

from which:

$c = + 0.00463$ mm.

$\mu = + 0.00014$ mm. $= + 0''.0029$, or $+ 0''.011$ per year.

$\pi = + 0.00093$ mm. $= + \mathbf{0''.019 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00138 \text{ mm.} = \pm 0''.029.$$

ϵ CEPHEI ($22^h\ 11^m$; $+56°\ 32'$)

This star of magnitude 4.23 and of A5 type has a total proper motion 0″.452. With the heliometer Chase found the parallax + 0″.110 ± 0″.015, by photography with the 40-inch refractor Slocum and Mitchell found the result + 0″.060 ± 0″.009, while at Allegheny by photography the result is + 0″.027 ± 0″.011. Miss Hawes measured the plates and found the parallax + 0″.053 ± 0″.008 with a proper motion in right ascension + 0″.462 where the corresponding value from Boss is + 0″.450.

TABLE 1

PLATES OF ϵ CEPHEI

No.	Date.	Hour Angle.	Observers.	Weight.
3215	1916 Oct. 19	−0ʰ4	M	1.0
3216	Oct. 19	0.0	M	1.0
3272	Oct. 25	−0.9	L	1.0
3273	Oct. 25	−0.5	L	1.0
4689	1917 Nov. 3	−0.4	A	1.0
4799	Nov. 22	−0.1	Ol	0.9
4818	Nov. 28	−0.1	M	1.0
5582	1918 Aug. 2	0.0	A	1.0
5583	Aug. 2	+0.2	A	0.7*
5597	Aug. 5	−0.4	A	1.0
5598	Aug. 5	−0.1	A	0.9
5810	Oct. 15	−0.2	H, D	1.0
5987	Nov. 23	0.0	D, H	1.0
5998	Nov. 25	−0.1	M	0.9
7158	1919 June 2	−1.8	M	1.0
7159	June 2	−1.5	M	0.8
7246	June 29	−1.3	Ol	0.9
7247	June 29	−0.9	Ol	1.0
7248	June 29	−0.5	Ol	1.0
7823	Sept. 27	−0.5	D	1.0
7824	Sept. 27	−0.2	D	1.0
7869	Sept. 30	−0.5	D	1.0
7870	Sept. 30	−0.2	D	1.0
7871	Sept. 30	+0.2	D	0.7*

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.11	−39.5	+ 7.0	+0.177
2	.14	−21.1	+11.5	.178
3	.12	+ 3.2	−11.5	.215
4	.14	+11.8	−29.0	.240
5	.12	+45.6	+22.0	+0.190
Parallax star	0.15	+ 1.4	− 2.0	

TABLE 2

REDUCTIONS FOR ϵ CEPHEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3215	−0.0412	1.0	−0.766	−679	+0.0026	+0″.05
3216	− .0373	1.0	− .766	−679	− .0013	− .03
3272	− .0371	1.0	− .815	−673	− .0013	− .03
3273	− .0383	1.0	− .815	−673	− .0001	.00
4689	− .0164	1.0	− .871	−299	+ .0007	+ .01
4799	− .0156	0.9	− .923	−280	+ .0009	+ .02
4818	− .0146	1.0	− .918	−274	+ .0003	+ .01
5582	+ .0022	1.0	+ .338	− 27	+ .0017	+ .04
5583	+ .0007	0.7	+ .338	− 27	+ .0032	+ .06
5597	+ .0031	1.0	+ .293	− 24	+ .0009	+ .02
5598	+ .0064	0.9	+ .293	− 24	− .0024	− .05
5810	+ .0086	1.0	− .723	+ 47	− .0029	− .06
5987	+ .0084	1.0	− .923	+ 86	− .0008	− .02
5998	+ .0101	0.9	− .922	+ 88	− .0024	− .05
7158	+ .0244	1.0	+ .932	+277	− .0004	− .01
7159	+ .0260	0.8	+ .932	+277	− .0020	− .04
7246	+ .0249	0.9	+ .764	+304	+ .0003	+ .01
7247	+ .0254	1.0	+ .764	+304	− .0002	.00
7248	+ .0256	1.0	+ .764	+304	− .0004	− .01
7823	+ .0286	1.0	− .510	+394	− .0012	− .02
7824	+ .0260	1.0	− .510	+394	+ .0014	+ .03
7869	+ .0269	1.0	− .549	+397	+ .0006	+ .01
7870	+ .0254	1.0	− .549	+397	+ .0021	+ .04
7871	+0.0258	0.7	−0.549	+397	+0.0017	+0.03

The normal equations are:

$$22.8c - 1.682\mu - 5.7353\pi = + 0.0823 \text{ mm.}$$
$$+ 322.4020\mu + 28.1440\pi = + 2.0280 \text{ mm.}$$
$$+ 11.9573\pi = + 0.1751 \text{ mm.}$$

from which:

$c = + 0.00470$ mm.
$\mu = + 0.00609$ mm. $= + 0''.1267$, or $+ 0''.462$ per year.
$\pi = + 0.00256$ mm. $= + \mathbf{0''.053} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00110 \text{ mm.} = \pm 0''.023.$$

LALANDE 43492 ($22^h\ 12^m$; $+12°\ 24'$)

This star of magnitude 6.9, of Go type and of total proper motion $0''.85$ has had its parallax several times determined, as follows:

Authority.	Method.	Parallax.
Chase	Heliometer	$+0''.140 \pm 0''.065$
Russell	Photography	$+ .021 \pm .023$
Flint	Meridian circle	$+ .019 \pm .033$
Jewdokimov	Meridian circle	$- .024 \pm .105$
Allegheny	Photography	$+ .033 \pm .009$
Adams	Spectrograph	$+0.058$

Mr. Alden measured the McCormick plates, and found a relative parallax $+ 0''.052 \pm 0''.007$, with a proper motion in right ascension $+ 0''.839$ while the corresponding value from Porter is $+ 0''.847$.

TABLE 1

PLATES OF LALANDE 43492

No.	Date.	Hour Angle.	Observers.	Weight.
3347	1916 Nov. 5	+0h6	M	0.6*
3370	Nov. 8	+0.1	A	0.8
3371	Nov. 8	+0.4	A	0.9
3482	Dec. 6	+1.0	Ol	0.8
4253	1917 Aug. 11	+0.2	B	0.8
4254	Aug. 11	+0.5	B	0.7
4582	Oct. 15	+0.8	Ds	0.6
4755	Nov. 10	+0.9	Ds	0.8
4854	Dec. 9	+0.6	M	0.5*
4878	Dec. 15	+1.1	M	1.0
5558	1918 July 14	+0.3	A	1.0
5559	July 14	+0.5	A	1.0
5578	July 21	+0.5	A	1.0
5579	July 21	+0.9	A	0.7*
5607	Aug. 6	−0.9	A	1.0
5608	Aug. 6	−0.7	A	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.16	−59.0	+15.6	+0.2015
2	.15	−41.0	−17.9	.1658
3	.14	− 5.1	+35.2	.2417
4	.09	+37.2	−44.3	.1568
5	.17	+67.9	+11.4	+0.2342
Parallax star	0.15	+ 1.8	+ 4.4	

TABLE 2

REDUCTIONS FOR LALANDE 43492

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3347	−0.0094	0.6	−0.881	−367	−0.0001	0″.00
3370	− .0087	0.8	− .894	−364	− .0005	− .01
3371	− .0106	0.9	− .894	−364	+ .0014	+ .03
3482	− .0057	0.8	− .896	−336	− .0004	− .01
4253	+ .0250	0.8	+ .202	− 88	− .0009	− .02
4254	+ .0233	0.7	+ .202	− 88	+ .0008	+ .01
4582	+ .0313	0.6	− .142	− 23	− .0009	− .01
4755	+ .0321	0.8	− .901	+ 3	− .0007	− .01
4854	+ .0335	0.5	− .884	+ 32	+ .0011	+ .02
4878	+ .0358	1.0	− .851	+ 38	− .0004	− .01
5558	+ .0618	1.0	+ .601	+249	+ .0005	+ .01
5559	+ .0630	1.0	+ .601	+249	− .0007	− .01
5578	+ .0630	1.0	+ .511	+256	− .0001	.00
5579	+ .0631	0.7	+ .511	+256	− .0002	.00
5607	+ .0634	1.0	+ .283	+272	+ .0007	+ .01
5608	+0.0636	0.9	+0.283	+272	+0.0005	+0.01

The normal equations are:

$$13.1c + 2.528\mu - 1.9528\pi = + 0.4592 \text{ mm.}$$
$$+ 78.6253\mu + 15.8264\pi = + 0.9928 \text{ mm.}$$
$$+ 5.6228\pi = + 0.1240 \text{ mm.}$$

from which:

$c = + 0.03330$ mm.

$\mu = + 0.01105$ mm. $= + 0''.2299$, or $+ 0''.839$ per year.

$\pi = + 0.00250$ mm. $= + \mathbf{0''.052 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00047 \text{ mm.} = \pm 0''.010.$$

ζ AQUARII ($22^h\ 23^m$; $-0°\ 31'$)

This well-known double of magnitudes 4.42 and 4.59 and of type F5 has a considerable proper motion 0".18 per year. According to Burnham's General Catalogue, "It is evident that neither by computation nor conjecture can any one at this time be reasonably certain of naming a period which shall be within one thousand years of the correct time." Thirteen of the McCormick photographs were measured by Mr. Alden, the balance by Mr. Mitchell. The parallaxes of the brighter and

TABLE 1

PLATES OF ζ AQUARII

No.	Date.	Hour Angle.	Observers.	Weight
1886	1915 Oct. 28	+0h4	M	0.7
2062	Nov. 25	+0.1	M	0.9
2779	1916 June 26	−1.0	M	0.7
2780	June 26	−0.6	M	0.7
3254	Oct. 23	−0.1	L	1.0
3354	Nov. 7	−0.1	L	1.0
3355	Nov. 7	+0.3	L, M	1.0
3420	Nov. 21	+0.6	L	1.0
4267	1917 Aug. 13	+0.5	A	1.0
4268	Aug. 13	+1.0	A	1.0
4680	Nov. 2	+0.7	B	0.8
4681	Nov. 2	+1.2	B	1.0
4698	Nov. 4	−0.2	M	1.0
4699	Nov. 4	+0.2	M	1.0
4703	Nov. 5	−0.4	A	1.0
4704	Nov. 5	0.0	A	1.0
5570	1918 July 20	+0.6	A	1.0
5571	July 20	+1.1	A	1.0
5611	Aug. 6	+0.8	A	1.0
5897	Nov. 6	+0.3	M	0.7
5905	Nov. 7	−0.2	D	0.7
5972	Nov. 14	+0.3	F	1.0
5973	Nov. 14	+0.7	F	1.0

TABLE 2

REDUCTIONS FOR ζ^1 AQUARII, BRIGHTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1886	−0.0710	0.7	−0.803	−661	+0.0020	+0″.03
2062	− .0668	0.9	− .919	−633	− .0019	− .04
2779	− .0581	0.7	+ .812	−419	− .0034	− .06
2780	− .0635	0.7	+ .812	−419	+ .0020	+ .04
3254	− .0612	1.0	− .768	−300	− .0004	− .01
3354	− .0642	1.0	− .872	−285	+ .0028	+ .06
3355	− .0658	1.0	− .872	−285	+ .0044	+ .09
3420	− .0590	1.0	− .916	−271	− .0022	− .05
4267	− .0531	1.0	+ .219	− 6	− .0008	− .02
4268	− .0551	1.0	+ .219	− 6	+ .0012	+ .02
4680	− .0512	0.8	− .842	+ 75	− .0028	− .05
4681	− .0492	1.0	− .842	+ 75	− .0048	− .10
4698	− .0540	1.0	− .854	+ 77	.0000	.00
4699	− .0550	1.0	− .854	+ 77	+ .0010	+ .02
4703	− .0530	1.0	− .860	+ 78	− .0010	− .02
4704	− .0538	1.0	− .860	+ 78	− .0002	.00
5570	− .0498	1.0	+ .563	+335	+ .0034	+ .07
5571	− .0464	1.0	+ .563	+335	.0000	.00
5611	− .0430	1.0	+ .328	+352	− .0034	− .07
5897	− .0528	0.7	− .865	+444	+ .0064	+ .11
5905	− .0470	0.7	− .869	+445	+ .0006	+ .01
5972	− .0456	1.0	− .900	+452	− .0007	− .01
5973	−0.0452	1.0	−0.900	+452	−0.0011	−0.02

fainter stars are $+ 0''.034 \pm 0''.013$, and $+ 0''.029 \pm 0''.010$, respectively, so that the parallax of the system is $+ 0''.032 \pm 0''.008$. Proper motions of $+ 0''.156$ and $+ 0''.166$ for ζ^1 and ζ^2 Aquarii resulted from the photographs, while the values from Boss are $+ 0''.172$ and $+ 0''.207$, respectively. The spectroscopic parallaxes for ζ^1 and ζ^2 are $+ 0''.028$ and $+ 0''.029$, respectively.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−43.3	+12.8	+0.1402
2	.16	−36.0	+45.9	.1879
3	.08	−28.2	−11.5	.1251
4	.17	+17.6	−17.7	.1621
5	.12	+35.9	+ 6.0	.2090
6	.10	+54.0	−35.5	+0.1757
Brighter star	.12	+ 3.5	+ 1.1	
Fainter star	0.10			

The normal equations are:

$$21.2c + 2.213\mu - 9.7458\pi = - 1.1592 \text{ mm.}$$
$$+ 230.5939\mu + 1.5202\pi = + 0.3568 \text{ mm.}$$
$$+ 12.8080\pi = + 0.5516 \text{ mm.}$$

from which:

$c = - 0.05415$ mm.

$\mu = + 0.00206$ mm. $= + 0''.0428$, or $+ 0''.156$ per year.

$\pi = + 0.00162$ mm. $= + \mathbf{0''.034 \pm 0''.013}$.

Probable error of plate of unit weight

$$\pm 0.00175 \text{ mm.} = \pm 0''.036.$$

TABLE 3

REDUCTIONS FOR ζ^2 AQUARII, FAINTER STAR

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1886	+0.0388	0.7	−0.803	−661	−0.0016	−0″.03
2062	+ .0383	0.9	− .919	−633	− .0006	− .01
2779	+ .0450	0.7	+ .812	−419	− .0003	− .01
2780	+ .0433	0.7	+ .812	−419	+ .0014	+ .02
3254	+ .0444	1.0	− .768	−300	+ .0007	+ .01
3354	+ .0454	1.0	− .872	−285	− .0001	.00
3355	+ .0462	1.0	− .872	−285	− .0009	− .02
3420	+ .0461	1.0	− .916	−271	− .0005	− .01
4267	+ .0533	1.0	+ .219	− 6	− .0004	− .01
4268	+ .0535	1.0	+ .219	− 6	− .0006	− .01
4680	+ .0518	0.8	− .842	+ 75	+ .0014	+ .03
4681	+ .0545	1.0	− .842	+ 75	− .0013	− .03
4698	+ .0501	1.0	− .854	+ 77	+ .0032	+ .07
4699	+ .0524	1.0	− .854	+ 77	+ .0008	+ .02
4703	+ .0523	1.0	− .860	+ 78	+ .0010	+ .02
4704	+ .0520	1.0	− .860	+ 78	+ .0013	+ .03
5570	+ .0584	1.0	+ .563	+335	+ .0024	+ .05
5571	+ .0600	1.0	+ .563	+335	+ .0008	+ .02
5611	+ .0652	1.0	+ .328	+352	− .0043	− .09
5897	+ .0590	0.7	− .865	+444	+ .0022	+ .04
5905	+ .0596	0.7	− .869	+445	+ .0017	+ .03
5972	+ .0666	1.0	− .900	+452	− .0052	− .11
5973	+0.0612	1.0	−0.900	+452	+0.0002	0.00

The normal equations are:

$$21.2c + 2.213\mu - 9.7458\pi = + 1.1095 \text{ mm.}$$
$$+ 230.5939\mu + 1.5202\pi = + 0.6228 \text{ mm.}$$
$$+ 12.8080\pi = - 0.4931 \text{ mm.}$$

from which:

$c = + 0.05274$ mm.

$\mu = + 0.00219$ mm. $= + 0''.0455$, or $+ 0''.166$ per year.

$\pi = + 0.00137$ mm. $= +$ **0″.029 ± 0″.010.**

Probable error of plate of unit weight

$$\pm 0.00135 \text{ mm.} = \pm 0''.028.$$

KRUEGER 60 ($22^h\ 24^m$; $+57°\ 11'$)

This star has long been noted as an exceptional star on account of its large proper motion amounting to 0".94 per year, its rapid orbital motion, and its large parallax. Our knowledge of the pair has been mainly through the magnificent series of observations made by Barnard. The preceding star of Krueger's wide pair, separated 12", was discovered by Burnham in 1890 to be an unequal double, with a distance of 2".3. As noted by Barnard (*Monthly Notices*, May, 1916), Krueger's two stars have no physical connection, and their proximity in space is purely accidental, while the pair discovered by Burnham is a binary of a very interesting character. The truth of this remark will be borne out by the parallax measures described below.

The parallax has been three times determined as follows: Barnard by micrometric measures obtained $+ 0".249 \pm 0".010$, Russell by photography $+ 0".258 \pm 0".019$, and Schlesinger by photography with the Yerkes refractor $+ 0".252 \pm 0".006$. These three measures were made of the brighter component, A, of the pair. According to Aitken, this star has a magnitude 9.3 while the companion, B, is of magnitude 10.8. A is of spectral type Mb, according to Adams. The distant star, C, forming with AB the stars of Krueger's double is of magnitude 10.0, and in consequence of the large proper motion of the pair AB the distance has now increased to 50", or as Barnard has expressed it, "this star has been left behind in space." C has no sensible proper motion. In view of the interest attaching to this system, it seemed worth while to determine the parallaxes and the proper motions of all three stars, A, B, and C. The plates taken for this purpose, and the measures made by Mr. Mitchell follow:

TABLE 1

PLATES OF KRUEGER 60

No.	Date.	Hour Angle.	Observers.	Weight.
3418	1916 Nov. 21	−0ʰ4	M	1.0
3419	Nov. 21	−0.1	M	1.0
3437	Nov. 26	−0.3	M	1.0
3438	Nov. 26	0.0	M	1.0
4166	1917 July 4	−0.7	M	1.0
4167	July 4	−0.4	M	1.0
4168	July 4	0.0	M	1.0
4696	Nov. 4	−1.0	M	1.0
4697	Nov. 4	−0.7	M	0.8
4701	Nov. 5	−1.2	M	1.0
4702	Nov. 5	−0.8	M	1.0
4727	Nov. 7	−1.0	M	1.0
4728	Nov. 7	−0.7	M	1.0
5511	1918 July 2	−0.4	A	1.0
5512	July 2	−0.1	A	0.7
5513	July 2	0.0	A	0.5*
5570	July 20	+0.2	A	0.8
5609	Aug. 6	−0.2	A	0.8
5871	Nov. 3	−0.2	M	0.8
5903	Nov. 7	−1.4	M	1.0
5970	Nov. 14	−0.6	M	0.8
5971	Nov. 14	−0.3	M	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.	
				A and B.	C.
	mm.	mm.	mm.		
1	0.14	−30.6	− 7.8	+0.185	+0.154
2	.12	−22.1	+22.1	.180	.175
3	.11	− 1.3	+32.0	.168	.187
4	.09	− 1.1	−32.9	.167	.145
5	.17	+26.6	+ 2.5	.151	.175
6	.09	+28.5	−15.9	+0.149	+0.164
A and B	.12 and .06	− 1.8	+ 0.4		
C	0.09	+ 0.4	+ 1.7		

TABLE 2

REDUCTIONS FOR KRUEGER 60, A

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3418	+0.0144	1.0	−0.916	−393	+0.0016	+0″.03
3419	+ .0148	1.0	− .916	−393	+ .0012	+ .02
3437	+ .0148	1.0	− .919	−388	+ .0007	+ .01
3438	+ .0148	1.0	− .919	−388	+ .0007	+ .01
4166	+ .0204	1.0	+ .743	−168	− .0030	− .06
4167	+ .0146	1.0	+ .743	−168	+ .0028	+ .06
4168	+ .0176	1.0	+ .743	−168	− .0002	.00
4696	− .0159	1.0	− .853	− 45	+ .0019	+ .04
4697	− .0137	0.8	− .853	− 45	− .0003	.00
4701	− .0088	1.0	− .859	− 44	− .0053	− .11
4702	− .0114	1.0	− .859	− 44	− .0027	− .06
4727	− .0146	1.0	− .870	− 42	+ .0001	.00
4728	− .0128	1.0	− .870	− 42	− .0017	− .04
5511	− .0144	1.0	+ .764	+195	.0000	.00
5512	− .0097	0.7	+ .764	+195	− .0047	− .08
5513	− .0185	0.5	+ .764	+195	+ .0041	+ .06
5570	− .0228	0.8	+ .565	+213	+ .0042	+ .08
5609	− .0210	0.8	+ .330	+230	− .0021	− .04
5871	− .0504	0.8	− .846	+319	+ .0043	+ .08
5903	− .0482	1.0	− .869	+323	+ .0015	+ .03
5970	− .0480	0.8	− .899	+330	+ .0003	.00
5971	−0.0462	1.0	−0.899	+330	−0.0015	−0.03

The normal equations are:

$$20.2c - 3.634\mu - 7.2016\pi = -0.2017 \text{ mm.}$$
$$+ 124.9731\mu + 7.3057\pi = -0.9858 \text{ mm.}$$
$$+ 13.7318\pi = +0.1622 \text{ mm.}$$

from which:

$c = -0.00699$ mm.

$\mu = -0.00884$ mm. $= -0''.1839$, or $-0''.671$ per year.

$\pi = +0.01285$ mm. $= +\mathbf{0''.267 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00173 \text{ mm.} = \pm 0''.036.$$

TABLE 3

REDUCTIONS FOR KRUEGER 60, B

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3418	+0.1088	1.0	−0.916	−393	+0.0020	+0″.04
3419	+ .1084	1.0	− .916	−393	+ .0024	+ .05
3437	+ .1098	1.0	− .919	−388	+ .0003	+ .01
3438	+ .1050	1.0	− .919	−388	+ .0051	+ .11
4166	+ .1064	1.0	+ .743	−168	− .0025	− .05
4167	+ .1058	1.0	+ .743	−168	− .0019	− .04
4168	+ .1082	1.0	+ .743	−168	− .0043	− .09
4696	+ .0679	1.0	− .853	− 45	+ .0003	+ .01
4697	+ .0686	0.8	− .853	− 45	− .0004	− .01
4701	+ .0724	1.0	− .859	− 44	− .0044	− .09
4702	+ .0706	1.0	− .859	− 44	− .0026	− .05
4727	+ .0664	1.0	− .870	− 42	+ .0012	+ .02
4728	+ .0726	1.0	− .870	− 42	− .0050	− .10
5511	+ .0521	1.0	+ .764	+195	+ .0068	+ .14
5512	+ .0600	0.7	+ .764	+195	− .0011	− .02
5513	+ .0549	0.5	+ .764	+195	+ .0040	+ .06
5570	+ .0527	0.8	+ .565	+213	+ .0014	+ .02
5871	+ .0194	0.8	− .846	+319	+ .0035	+ .07
5903	+ .0210	1.0	− .869	+323	+ .0011	+ .02
5970	+ .0238	0.8	− .899	+330	− .0029	− .05
5971	+0.0220	1.0	−0.899	+330	−0.0011	−0.02

The normal equations are:

$$19.4c - 5.474\mu - 7.4656\pi = + 1.3984 \text{ mm.}$$
$$+ 120.7411\mu + 6.6985\pi = - 1.8222 \text{ mm.}$$
$$+ 13.6446\pi = - 0.4584 \text{ mm.}$$

from which:

$c = + 0.07346$ mm.

$\mu = - 0.01247$ mm. $= - 0''.2593$, or $- 0''.946$ per year.

$\pi = + 0.01272$ mm. $= + \mathbf{0''.265 \pm 0''.014}$.

Probable error of plate of unit weight

$$\pm 0.00221 \text{ mm.} = \pm 0''.046.$$

TABLE 4

REDUCTIONS FOR KRUEGER 60, C

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3418	+0.0301	1.0	−0.916	−393	+0.0023	+0″.05
3419	+ .0306	1.0	− .916	−393	+ .0018	+ .04
3437	+ .0346	1.0	− .919	−388	− .0022	− .05
3438	+ .0306	1.0	− .919	−388	+ .0018	+ .04
4166	+ .0358	1.0	+ .743	−168	− .0032	− .07
4167	+ .0318	1.0	+ .743	−168	+ .0008	+ .02
4168	+ .0314	1.0	+ .743	−168	+ .0012	+ .02
4696	+ .0335	1.0	− .853	− 45	− .0008	− .02
4697	+ .0309	0.8	− .853	− 45	+ .0018	+ .03
4701	+ .0326	1.0	− .859	− 44	+ .0001	.00
4702	+ .0359	1.0	− .859	− 44	− .0032	− .07
4727	+ .0366	1.0	− .870	− 42	− .0039	− .08
4728	+ .0326	1.0	− .870	− 42	+ .0001	.00
5511	+ .0320	1.0	+ .764	+195	+ .0009	+ .02
5512	+ .0365	0.7	+ .764	+195	− .0036	− .06
5513	+ .0275	0.5	+ .764	+195	+ .0054	+ .08
5570	+ .0312	0.8	+ .565	+213	+ .0018	+ .03
5609	+ .0350	0.8	+ .330	+230	− .0020	− .04
5871	+ .0343	0.8	− .846	+319	− .0013	− .02
5903	+ .0310	1.0	− .869	+323	+ .0020	+ .04
5970	+ .0329	0.8	− .899	+330	+ .0001	.00
5971	+0.0314	1.0	−0.899	+330	+0.0016	+0.03

The normal equations are:

$$20.2c - 3.634\mu - 7.2016\pi = + 0.6612 \text{ mm.}$$
$$+ 124.9731\mu + 7.3057\pi = - 0.1085 \text{ mm.}$$
$$+ 13.7318\pi = - 0.2349 \text{ mm.}$$

from which:

$c = + 0.03276$ mm.

$\mu = + 0.00008$ mm. $= + 0''.0017$, or $+ 0''.006$ per year.

$\pi = + 0.00003$ mm. $= + \mathbf{0''.001 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00152 \text{ mm.} = \pm 0''.032.$$

For the pair AB, the parallaxes derived are, + 0″.267 ± 0″.011, and + 0″.265 ± 0″.014, for brighter and fainter, respectively. The parallax of the system is, therefore,

+ 0″.266 ± 0″.009.

The parallax of the star C is + 0″.001 ± 0″.010.

The proper motions in right ascension for the three stars, A, B, and C are − 0″.671, − 0″.946, and + 0″.006.

From the parallax and proper motion of the star C, it is evident that its parallax and proper motion are practically the same in size as those of the comparison stars, and therefore, we must conclude with Burnham (*General Catalogue* 11761), that C is fixed in space.

The proper motion in right ascension of the pair AB has been determined by Porter to amount to − 0″.797 per year. Unfortunately, this proper motion is the results of two meridian circle measures only, and consequently, for obvious reasons, its value cannot have a high degree of accuracy. As Russell has pointed out in *Astronomical Journal* **30**, 131, 1917, little is known of the proper motion of the center of gravity of the system, or of the relative masses of the components A and B. The present measures and Porter's proper motion show that the relative masses of A and B are in the approximate ratio 6 : 5, but in the present state of our knowledge, this figure is at best but a rough guess.

The present series of plates have been measured to determine the position angle and distances of the pairs AB, AC, and BC. These measures have been compared with the very excellent series of micrometer measures made by Barnard with the 40-inch Yerkes refractor. The details of these measures appear elsewhere (*Astronomical Journal,* **32,** *177, 1920*). The measures indicate that even when a double is as close as 2″, or 0.1 millimeter on the McCormick plates, the measures on the photographs have as high a degree of accuracy as similar measures with the micrometer.

In the Astronomical Journal (*loc. cit.*), Russell has discussed the elements of this pair, and has given two possible orbits that satisfy the observations made up to 1916 equally well. Un-

published observations by Barnard made by the micrometer, and the measures of the position angle and distance of the photographs, referred to above, seem to indicate that the second of the orbits with a period of 54.9 years represents these later observations the better. With this assumption, the mass of the system is 0.40 that of the sun, while the McCormick parallax gives the absolute magnitudes of A and B to be 11.5 and 13.0, or respectively, 6.5 and 8.0 magnitudes fainter than our own sun. This gives to B a luminosity about one-two-thousandth that of the sun, which is about equivalent to the luminosity of Barnard's star of large proper motion. These two stars are among the faintest suns that are as yet known to astronomy.

η PEGASI ($22^h\ 38^m$; $+29°\ 42'$)

Four values have been found for the parallax of this star which is of 3.10 magnitude, of Go type, and of small proper motion 0".036. Flint with the meridian circle found the relative parallax of $-\ 0''.028 \pm 0''.027$, the Allegheny Observatory by photography the relative parallax of $-\ 0''.002 \pm 0''.013$, Swarthmore the photographic parallax $-\ 0''.004 \pm 0''.012$, and Adams with the spectrograph the absolute parallax of $+\ 0''.022$. Mr. Olivier measured the plates and found a parallax of $-\ 0''.008 \pm 0''.010$, with a proper motion in right ascension of $-\ 0''.058$ per year while the value from Boss is $+\ 0''.010$.

TABLE 1

PLATES OF η PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
121	1914 July 9	−0h6	M	0.9
122	July 9	−0.2	M	0.5*
149	July 21	−1.0	M	0.9
384	Oct. 9	−0.6	G	0.6
464	Nov. 1	−0.3	M	0.8
470	Nov. 2	−0.1	M, G	0.8
478	Nov. 3	0.0	M	0.8
492	Nov. 4	−0.3	G	1.0
509	Nov. 5	−0.5	A	0.9
520	Nov. 6	−0.3	A	1.0
1439	1915 July 6	−0.2	A	0.8
1461	July 13	−1.0	A	1.0
1462	July 13	−0.6	A	1.0
3444	1916 Nov. 27	−0.3	M	0.8
3445	Nov. 27	0.0	M	0.6*
3450	Nov. 30	−0.2	M	0.9
3451	Nov. 30	0.0	M	0.9
3481	Dec. 6	−0.1	Ol	0.9
3516	Dec. 10	0.0	M	0.9
4646	1917 Oct. 30	−0.2	B	0.7
4844	Dec. 5	−0.1	M	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.22	−51.2	+35.4	+0.2381
2	.18	−44.6	−26.0	.1165
3	.19	+38.6	−18.9	.2758
4	.12	+57.2	+ 9.5	+0.3696
Parallax star	0.20	+14.4	+ 3.7	

TABLE 2

REDUCTIONS FOR η PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p} \cdot v$ in Arc.
	mm.				mm.	
121	−0.0238	0.9	+0.732	−458	+0.0002	0″.00
122	− .0236	0.5	+ .732	−458	.0000	.00
149	− .0240	0.9	+ .599	−446	+ .0003	+ .01
384	− .0260	0.6	− .586	−366	+ .0022	+ .04
464	− .0259	0.8	− .802	−343	+ .0020	+ .04
470	− .0213	0.8	− .810	−342	− .0026	− .05
478	− .0242	0.8	− .817	−341	+ .0003	.00
492	− .0251	1.0	− .824	−340	+ .0012	+ .02
509	− .0254	0.9	− .831	−339	+ .0015	+ .03
520	− .0205	1.0	− .838	−338	− .0034	− .07
1439	− .0273	0.8	+ .763	− 96	+ .0009	+ .02
1461	− .0236	1.0	+ .693	− 89	− .0028	− .06
1462	− .0280	1.0	+ .693	− 89	+ .0016	+ .03
3444	− .0296	0.8	− .914	+414	.0000	.00
3445	− .0267	0.6	− .914	+414	− .0029	− .05
3450	− .0327	0.9	− .915	+417	+ .0031	+ .06
3451	− .0278	0.9	− .915	+417	− .0018	− .04
3481	− .0288	0.9	− .908	+423	− .0009	− .02
3516	− .0310	0.9	− .898	+427	+ .0013	+ .02
4646	− .0298	0.7	− .789	+751	− .0024	− .04
4844	−0.0347	0.9	−0.910	+787	+0.0023	+0.04

The normal equations are:

$$17.6c + 0.083\mu - 7.0677\pi = - 0.4695 \text{ mm.}$$
$$+ 302.0590\mu - 22.4822\pi = - 0.2227 \text{ mm.}$$
$$+ 11.6069\pi = + 0.2021 \text{ mm.}$$

from which:

$c = - 0.02683$ mm.

$\mu = - 0.00076$ mm. $= - 0''.0158$, or $- 0''.058$ per year.

$\pi = - 0.00039$ mm. $= - \mathbf{0''.008 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00128 \text{ mm.} = \pm 0''.027.$$

ξ PEGASI ($22^h\ 41^m$; $+11°\ 39'$)

This star is Lalande 44552, and is of 4.31 magnitude, of F5 type, and of total proper motion 0″.54 per year. Chase has found the parallax with the Yale heliometer to be + 0″.080 ± 0″.047. The Allegheny parallax by photography is + 0″.044 + 0″.009, and the spectroscopic value of Adams and Joy is + 0″.079. At a distance of 12″ there is a companion of 12.8 magnitude which has the same proper motion as ξ Pegasi, so that they probably form a physical system. The McCormick plates were measured by Mr. Lamb, who found a proper motion in right ascension of + 0″.204 per year while the value from Boss is + 0″.227.

TABLE 1

PLATES OF ξ PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
390	1914 Oct. 11	+0^h.5	M	0.5*
451	Oct. 31	+0.4	A, M	1.0
692	Dec. 21	+0.8	Ol	0.7
1502	1915 July 23	−0.7	G	0.8
1503	July 23	−0.2	G	1.0
1514	July 24	+0.4	A	0.7
1522	Aug. 5	−0.3	G	0.5*
1548	Aug. 13	−0.1	G	0.9
1549	Aug. 13	+0.4	G	0.8
1869	Oct. 27	−0.1	G	1.0
1870	Oct. 27	+0.5	M	1.0
1940	Nov. 1	+0.3	G	1.0
1941	Nov. 1	+0.8	G	1.0
2794	1916 July 3	−0.8	M	0.9
2795	July 3	−0.3	M	0.9
2801	July 5	−0.4	L	0.8
2802	July 5	+0.1	L	1.0
2829	July 20	−1.1	L	0.9
2830	July 20	−0.6	L	0.7

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.15	−37.0	−21.0	+0.281
2	.13	−35.0	+11.8	.302
3	.18	+32.9	+31.7	.231
4	.15	+39.1	−22.5	+0.186
Parallax star	0.16	− 6.1	+ 0.8	

TABLE 2

REDUCTIONS FOR ξ PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
390	+0.0222	0.5	−0.580	−360	−0.0018	−0″.02
451	+ .0230	1.0	− .786	−309	− .0025	− .05
692	+ .0217	0.7	− .856	−380	.0000	.00
1502	+ .0322	0.8	+ .589	− 95	− .0015	− .03
1503	+ .0297	1.0	+ .589	− 95	+ .0010	+ .02
1514	+ .0281	0.7	+ .577	− 94	+ .0026	+ .04
1522	+ .0282	0.5	+ .417	− 82	+ .0025	+ .03
1548	+ .0283	0.9	+ .301	− 74	+ .0023	+ .04
1549	+ .0309	0.8	+ .301	− 74	− .0003	.00
1869	+ .0307	1.0	− .750	+ 1	− .0004	− .01
1870	+ .0298	1.0	− .750	+ 1	+ .0005	+ .01
1940	+ .0299	1.0	− .792	+ 6	+ .0004	+ .01
1941	+ .0288	1.0	− .792	+ 6	+ .0015	+ .03
2794	+ .0393	0.9	+ .791	+251	+ .0012	+ .02
2795	+ .0415	0.9	+ .791	+251	− .0010	− .02
2801	+ .0412	0.8	+ .773	+253	− .0007	− .01
2802	+ .0444	1.0	+ .773	+253	− .0039	− .08
2829	+ .0404	0.9	+ .617	+268	+ .0002	.00
2830	+0.0396	0.7	+0.617	+268	+0.0010	+0.02

The normal equations are:

$$16.1c + 1.801\mu + 1.2275\pi = + 0.5221 \text{ mm.}$$
$$+ 64.7348\mu + 13.4763\pi = + 0.2623 \text{ mm.}$$
$$+ 7.5878\pi = + 0.0925 \text{ mm.}$$

from which:

$c = + 0.03195$ mm.
$\mu = + 0.00270$ mm. $= + 0''.0562$, or $+ 0''.205$ per year.
$\pi = + 0.00222$ mm. $= \mathbf{+ 0''.046 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00113 \text{ mm.} = \pm 0''.024.$$

μ PEGASI ($22^h\ 45^m$; $+24°\ 4'$)

The Allegheny parallax published for this star which is of K type, of 3.67 magnitude, and of total proper motion $0''.16$ is $+ 0''.043 \pm 0''.006$, while the spectroscopic value is $+ 0''.030$, Mr. Alden measured the plates and found a proper motion in right ascension amounting to $+ 0''.167$ while the value from Boss is $+ 0''.147$.

TABLE 1

PLATES OF μ PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
575	1914 Nov. 13	−0^h.4	Ol, G	0.8
582	Nov. 17	−0.2	A	1.0
624	Nov. 23	−0.2	Ol	0.8
638	Nov. 24	−0.2	M	0.9
1517	1915 July 31	−0.6	A	0.6*
1528	Aug. 6	−0.8	G	0.7*
1529	Aug. 6	−0.4	G	0.7
1570	Aug. 23	−0.4	A	0.8
1834	Oct. 23	−0.3	A	1.0
1835	Oct. 23	+0.1	A	1.0
1947	Nov. 2	−0.7	A	1.0
1948	Nov. 2	−0.2	M	0.7*
3443	1916 Nov. 27	−0.8	M	0.9
3450	Nov. 30	−0.7	M	1.0
3459	Dec. 1	−0.6	M	1.0
4158	1917 July 1	−1.1	A	1.0
4159	July 1	−0.6	A	1.0
4280	Aug. 18	−0.4	B	0.6*
4281	Aug. 18	0.0	B	0.7*
4630	Oct. 25	−0.1	A	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−35.6	+26.7	+0.4047
2	.22	−15.2	−38.4	.2378
3	.16	+50.8	+11.7	+0.3575
Parallax star	0.18	+ 0.1	+ 5.9	

TABLE 2

REDUCTIONS FOR μ PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
575	−0.0043	0.8	−0.865	−488	−0.0046	−0″.09
582	− .0084	1.0	− .883	−484	− .0005	− .01
624	− .0089	0.8	− .903	−478	+ .0002	.00
638	− .0097	0.9	− .905	−477	+ .0010	+ .02
1517	− .0080	0.6	+ .499	−228	+ .0044	+ .07
1528	− .0026	0.7	+ .418	−222	− .0009	− .01
1529	− .0062	0.7	+ .418	−222	+ .0027	+ .05
1570	+ .0014	0.8	+ .163	−205	− .0044	− .08
1834	+ .0001	1.0	− .701	−144	− .0015	− .03
1835	− .0044	1.0	− .701	−144	+ .0030	+ .06
1947	− .0020	1.0	− .792	−134	+ .0008	+ .02
1948	− .0039	0.7	− .792	−134	+ .0027	+ .05
3443	+ .0060	0.9	− .910	+257	+ .0015	+ .03
3450	+ .0074	1.0	− .914	+260	+ .0001	.00
3459	+ .0088	1.0	− .914	+261	− .0012	− .02
4158	+ .0115	1.0	+ .816	+473	+ .0002	.00
4159	+ .0131	1.0	+ .816	+473	− .0014	− .03
4280	+ .0133	0.6	+ .232	+521	− .0004	− .01
4281	+ .0127	0.7	+ .232	+521	+ .0002	.00
4630	+0.0152	1.0	−0.726	+589	−0.0005	−0.01

The normal equations are:

$$17.2c + 1.511\mu - 6.2847\pi = + 0.0317 \text{ mm.}$$
$$+ 236.0557\mu + 14.7107\pi = + 0.5178 \text{ mm.}$$
$$+ 9.5770\pi = + 0.0199 \text{ mm.}$$

from which:

$c = + 0.00155$ mm.

$\mu = + 0.00220$ mm. $= + 0''.0458$, or $+ 0''.167$ per year.

$\pi = - 0.00029$ mm. $= - \mathbf{0''.006 \pm 0''.012}$.

Probable error of plate of unit weight

$$\pm 0.00141 \text{ mm.} = \pm 0''.029.$$

ι CEPHEI ($22^h\ 46^m$; $+65°\ 40'$)

This is a Ko type star, of magnitude 3.68, and of total proper motion 0″.139. The Allegheny value of the parallax is + 0″.027 ± 0″.007, while the spectroscopic result of Adams furnishes the absolute parallax of + 0″.030. Mr. Alden measured the McCormick plates with the exception of the last six plates

TABLE 1

PLATES OF ι CEPHEI

No.	Date.	Hour Angle.	Observers.	Weight.
1902	1915 Oct. 29	−0ʰ2	Ol	0.9
1938	Nov. 1	−0.9	G	0.8
1939	Nov. 1	−0.5	G	1.0
2010	Nov. 11	−0.2	A	1.0
2101	Dec. 1	−0.5	Ol	0.6
2841	1916 Aug. 4	−0.8	A	0.9
2842	Aug. 4	−0.4	A	1.0
2852	Aug. 7	−0.5	A	1.0
2853	Aug. 7	−0.2	A	0.9
2860	Aug. 12	−0.4	A	1.0
2861	Aug. 12	−0.1	A	1.0
3286	Oct. 27	−0.4	L	1.0
3287	Oct. 27	−0.1	L	1.0
3307	Oct. 29	−0.4	A	0.8
3308	Oct. 29	−0.2	A	1.0
3324	Nov. 1	−0.4	A	0.9
5599	1918 Aug. 5	−0.2	A	1.0
5600	Aug. 5	+0.1	A	1.0
5619	Aug. 13	−1.1	A	0.9
5620	Aug. 13	−0.8	A	1.0
5872	Nov. 3	−0.2	M	1.0
5873	Nov. 3	+0.1	M	1.0
5929	Nov. 11	−1.1	H	1.0
5930	Nov. 11	−0.6	D	0.8
5952	Nov. 13	−0.9	H	1.0
5953	Nov. 13	−0.5	D	1.0

which were measured by Mr. Mitchell. The photographic proper motion in right ascension is − 0″.091 while the corresponding value from Boss is − 0″.068.

TABLE 2

REDUCTIONS FOR ι CEPHEI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1902	+0.0052	0.9	−0.756	−549	+0.0022	+0″.04
1938	+ .0083	0.8	− .782	−546	− .0010	− .02
1939	+ .0058	1.0	− .782	−546	+ .0015	+ .03
2010	+ .0078	1.0	− .852	−536	− .0008	− .02
2101	+ .0037	0.6	− .912	−516	+ .0030	+ .05
2841	+ .0070	0.9	+ .437	−269	− .0002	.00
2842	+ .0072	1.0	+ .437	−269	− .0004	− .01
2852	+ .0070	1.0	+ .394	−266	− .0003	− .01
2853	+ .0068	0.9	+ .394	−266	− .0001	.00
2860	+ .0066	1.0	+ .321	−261	− .0002	.00
2861	+ .0042	1.0	+ .321	−261	+ .0022	+ .05
3286	+ .0022	1.0	− .745	−185	+ .0009	+ .02
3287	+ .0058	1.0	− .745	−185	− .0027	− .06
3307	+ .0051	0.8	− .763	−183	− .0021	− .04
3308	+ .0050	1.0	− .763	−183	− .0020	− .04
3324	+ .0043	0.9	− .788	−180	− .0014	− .03
5599	− .0002	1.0	+ .429	+462	− .0018	− .04
5600	− .0046	1.0	+ .429	+462	+ .0026	+ .05
5619	− .0014	0.9	+ .314	+470	− .0010	− .02
5620	− .0015	1.0	+ .314	+470	− .0009	− .02
5872	− .0086	1.0	− .800	+552	+ .0027	+ .06
5873	− .0076	1.0	− .800	+552	+ .0017	+ .04
5929	− .0070	1.0	− .853	+560	+ .0009	+ .02
5930	− .0046	0.8	− .853	+560	− .0015	− .03
5952	− .0065	1.0	− .864	+562	+ .0003	+ .01
5953	−0.0046	1.0	−0.864	+562	−0.0016	−0.03

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−30.2	+ 5.9	+0.1718
2	.09	−21.4	+19.2	.1886
3	.15	− 7.7	−35.6	.1713
4	.12	+20.5	+42.0	.2459
5	.14	+38.8	−31.5	+0.2224
Parallax star	0.14	+ 3.1	+ 1.9	

The normal equations are:

$$24.5c + 3.306\mu - 8.2477\pi = + 0.0400 \text{ mm.}$$
$$+ 447.3148\mu - 0.9165\pi = - 0.5314 \text{ mm.}$$
$$+ 11.0589\pi = + 0.0054 \text{ mm.}$$

from which:

$c = + 0.00257$ mm.

$\mu = - 0.00120$ mm. $= - 0''.0250$, or $- 0''.091$ per year.

$\pi = + 0.00230$ mm. $= + \mathbf{0''.048 \pm 0''.008.}$

Probable error of plate of unit weight

$$\pm 0.00112 \text{ mm.} = \pm 0''.023.$$

LALANDE 45028 ($22^h\ 56^m$; $-4°\ 23'$)

Two values have been published for the parallax of this star which is of 7.8 magnitude, of K type, and of total proper motion $0''.54$. Smith with the Yale heliometer found a relative parallax of $+ 0''.038 \pm 0''.015$, and Adams by the spectrograph the absolute parallax of $+ 0''.046$. Mr. Olivier measured the plates and determined the proper motion in right ascension to be $+ 0''.405$ while the value from Porter is $+ 0''.0418$.

TABLE 1

PLATES OF LALANDE 45028

No.	Date.	Hour Angle.	Observers.	Weight.
1836	1915 Oct. 23	+0^{h}6	A	1.0
1903	Oct. 29	+0.1	Ol	0.8
1904	Oct. 29	+0.6	Ol	1.0
2017	Nov. 16	−0.4	Ol, A	0.8
2018	Nov. 16	+0.1	A	1.0
2823	1916 July 12	−0.4	Ol	0.9
2866	Aug. 13	−0.3	Ol	0.4
2867	Aug. 13	+0.1	Ol	0.9
2880	Aug. 17	−0.2	Ol	0.7
2881	Aug. 17	+0.2	Ol	0.9
2882	Aug. 17	+0.6	Ol	0.9
2883	Aug. 17	+1.1	Ol	0.8
3331	Nov. 2	0.0	L	1.0
3332	Nov. 2	+0.3	L	0.9
3356	Nov. 7	+0.4	M	1.0
3357	Nov. 7	+0.8	M	0.9
3414	Nov. 20	−0.2	Ol, A	0.9
3433	Nov. 22	+0.1	Ol, A	0.6

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−49.1	−23.5	+0.2698
2	.16	+ 1.9	+61.1	.1873
3	.24	+12.3	− 6.6	.2579
4	.17	+34.9	−31.0	+0.2850
Parallax star	0.18	+ 0.2	− 5.4	

TABLE 2

REDUCTIONS FOR LALANDE 45028

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1836	+0.0086	1.0	−0.666	−226	+0.0005	+0″.01
1903	+ .0088	0.8	− .727	−220	+ .0005	+ .01
1904	+ .0070	1.0	− .727	−220	+ .0023	+ .05
2017	+ .0118	0.8	− .861	−202	− .0019	− .03
2018	+ .0118	1.0	− .861	−202	− .0019	− .04
2823	+ .0279	0.9	+ .745	+ 37	− .0012	− .02
2866	+ .0292	0.4	+ .350	+ 69	− .0018	− .02
2867	+ .0276	0.9	+ .350	+ 69	− .0002	.00
2880	+ .0255	0.7	+ .291	+ 73	+ .0019	+ .03
2881	+ .0273	0.9	+ .291	+ 73	+ .0001	.00
2882	+ .0257	0.9	+ .291	+ 73	+ .0017	+ .03
2883	+ .0288	0.8	+ .291	+ 73	− .0014	− .02
3331	+ .0286	1.0	− .770	+150	+ .0002	.00
3332	+ .0256	0.9	− .770	+150	+ .0032	+ .06
3356	+ .0308	1.0	− .810	+155	− .0019	− .04
3357	+ .0284	0.9	− .810	+155	+ .0005	+ .01
3414	+ .0282	0.9	− .882	+168	+ .0012	+ .02
3433	+0.0336	0.6	−0.890	+170	−0.0042	−0.06

The normal equations are:

$$15.4c + 2.110\mu - 5.7684\pi = + 0.3476 \text{ mm.}$$
$$+ 36.7789\mu + 1.9564\pi = + 0.2477 \text{ mm.}$$
$$+ 7.2160\pi = - 0.1027 \text{ mm.}$$

from which:

$c = + 0.02281$ mm.

$\mu = + 0.00529$ mm. $= + 0''.1100$, or $+ 0''.405$ per year.

$\pi = + 0.00257$ mm. $= + \mathbf{0''.053 \pm 0''.011}$.

Probable error of plate of unit weight

$$\pm 0.00119 \text{ mm.} = \pm 0''.025.$$

β PEGASI ($22^h\ 58^m$; $+27°\ 32'$)

Four values of the parallax of β Pegasi have been published, but the results differ very greatly. Flint with the meridian circle found the relative parallax $-0''.047 \pm 0''.046$, while Jewdokimov, also with the meridian circle obtained a still

TABLE 1

PLATES OF β PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
124	1914 July 10	−0^{h}8	M, Ol	0.5
125	July 10	−0.3	M, Ol	0.6
131	July 15	−0.2	Ol	0.6
137	July 18	−1.0	M	0.8
143	July 19	−1.3	M	0.9
465	Nov. 1	0.0	M	1.0
493	Nov. 4	−0.1	M, G	0.8
510	Nov. 5	−0.3	M, A	0.9
521	Nov. 6	0.0	A	1.0
551	Nov. 11	−0.1	M, G	0.8
600	Nov. 21	−0.2	M, A	1.0
654	Nov. 26	0.0	M	1.0
658	Dec. 12	−0.1	M	0.8
1463	1915 July 13	−0.4	A	0.9
1464	July 13	0.0	A	1.0
1486	July 17	0.0	Ol	0.9
3460	1916 Dec. 1	−0.4	M	1.0
3461	Dec. 1	−0.1	M	0.9
3477	Dec. 5	−0.4	M	1.0
3478	Dec. 5	−0.1	M	1.0
4170	1917 July 9	−0.4	B	0.7
4216	July 31	−0.4	Ol	0.9
4217	July 31	−0.1	Ol	0.8
4666	Nov. 1	−0.8	A	1.0
4667	Nov. 1	−0.5	A	1.0
4717	Nov. 6	−0.4	Ds	1.0
4718	Nov. 6	−0.1	Ol	0.9

TABLE 2

REDUCTIONS FOR β PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
124	−0.0151	0.5	+0.773	−512	−0.0004	−0″.01
125	− .0150	0.6	+ .773	−512	− .0005	− .01
131	− .0188	0.6	+ .726	−507	+ .0034	+ .06
137	− .0177	0.8	+ .696	−504	+ .0024	+ .04
143	− .0151	0.9	+ .685	−503	− .0002	.00
465	− .0091	1.0	− .752	−399	− .0032	− .07
493	− .0110	0.8	− .777	−395	− .0011	− .02
510	− .0120	0.9	− .785	−394	− .0001	.00
521	− .0116	1.0	− .793	−393	− .0005	− .01
551	− .0126	0.8	− .829	−388	+ .0007	+ .01
600	− .0110	1.0	− .882	−378	− .0007	− .01
654	− .0115	1.0	− .898	−373	.0000	.00
658	− .0098	0.8	− .903	−357	− .0013	− .02
1463	− .0067	0.9	+ .748	−144	+ .0007	+ .01
1464	− .0064	1.0	+ .748	−144	+ .0004	+ .01
1486	− .0064	0.9	+ .708	−140	+ .0005	+ .01
3460	+ .0088	1.0	− .908	+363	− .0013	− .03
3461	+ .0052	0.9	− .908	+363	+ .0023	+ .05
3477	+ .0054	1.0	− .910	+367	+ .0022	+ .05
3478	+ .0061	1.0	− .910	+367	+ .0015	+ .03
4170	+ .0126	0.7	+ .779	+583	+ .0002	.00
4216	+ .0168	0.9	+ .540	+605	− .0033	− .07
4217	+ .0164	0.8	+ .540	+605	− .0029	− .05
4666	+ .0170	1.0	− .754	+698	− .0008	− .02
4667	+ .0155	1.0	− .754	+698	+ .0007	+ .01
4717	+ .0162	1.0	− .795	+703	+ .0001	.00
4718	+0.0146	0.9	−0.795	+703	+0.0017	+0.03

greater negative parallax of $-0''.190 \pm 0''.076$. The Allegheny value by photography is $+0''.018 \pm 0''.010$. Adams by means of the spectrograph found the absolute parallax amounting to $+0''.030$. The McCormick result from photographs measured by Mr. Olivier gives a relative parallax of $-0''.005 \pm 0''.006$. β Pegasi is a star of 2.61 magnitude, of Ma type, and of total proper motion $0''.234$ per year. In right ascension Boss finds a proper motion of $+0''.192$ while the value from the photographs is $+0''.197$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−57.1	+24.4	+0.4077
2	.22	+13.1	−46.0	.3312
3	.32	+44.0	+21.6	+0.2611
Parallax star	0.23	− 7.5	− 0.4	

The normal equations are:

$$23.7c + 6.595\mu - 6.6215\pi = -0.0306 \text{ mm.}$$
$$+530.6446\mu - 17.5699\pi = +1.3649 \text{ mm.}$$
$$+14.7970\pi = -0.0351 \text{ mm.}$$

from which:

$c = -0.00208$ mm.

$\mu = +0.00259$ mm. $= +0''.0539$, or $+0''.197$ per year.

$\pi = -0.00023$ mm. $= -\mathbf{0''.005 \pm 0''.006}$.

Probable error of plate of unit weight

$$\pm 0.00107 \text{ mm.} = \pm 0''.022.$$

7 ANDROMEDÆ ($23^h\ 8^m$; $+48°\ 51'$)

This star is of magnitude 4.62, of type F, and of total proper motion $0''.137$. The Allegheny parallax is $+0''.053 \pm 0''.013$, while the spectroscopic value of Mt. Wilson is $+0''.035$. Mr. Olivier measured the plates and derived a relative parallax $+0''.033 \pm 0''.010$, with a proper motion in right ascension $+0''.088$, where the corresponding value from Boss is $+0''.095$.

TABLE 1

PLATES OF 7 ANDROMEDÆ

No.	Date.	Hour Angle.	Observers.	Weight.
1920	1915 Oct. 30	$-0^h.2$	A	1.0
2071	Nov. 26	−0.4	Ol	0.5
2073	Nov. 27	−0.7	Ol	0.7
2145	Dec. 10	−0.4	Ol	0.8
4305	1917 Aug. 20	−0.5	A, B	1.0
4306	Aug. 20	−0.2	B	1.0
4800	Nov. 22	−0.5	Ol	0.9
4801	Nov. 22	−0.1	Ol	1.0
5585	1918 Aug. 2	+0.2	A	0.7*
5632	Aug. 19	−0.5	A	1.0
5633	Aug. 19	−0.1	A	1.0
5848	Nov. 2	−0.8	F, M	0.9
5849	Nov. 2	−0.3	F, M	0.9
7332	1919 July 24	−1.6	Ol	0.9
7333	July 24	−1.2	Ol	0.9
7334	July 24	−0.8	Ol	0.7
7358	July 26	−0.8	H	1.0
7359	July 26	−0.4	H	0.9
8136	Nov. 24	−0.7	M	0.9
8137	Nov. 24	−0.4	M, A	1.0
8162	Dec. 1	−0.8	Ol	1.0
8163	Dec. 1	−0.5	Ol	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−54.6	+39.7	+0.1876
2	.18	−33.9	−16.2	.2407
3	.19	+33.2	−31.8	.2935
4	.12	+55.3	+ 8.3	+0.2782
Parallax star	0.14	+ 6.7	− 3.5	

TABLE 2

REDUCTIONS FOR 7 ANDROMEDÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
1920	+0.0105	1.0	−0.705	−952	−0.0035	−0″.07
2071	+ .0068	0.5	− .888	−925	+ .0003	.00
2073	+ .0068	0.7	− .891	−924	+ .0003	.00
2145	+ .0085	0.8	− .907	−911	− .0013	− .02
4305	+ .0132	1.0	+ .296	−292	+ .0031	+ .06
4306	+ .0160	1.0	+ .296	−292	+ .0003	+ .01
4800	+ .0116	0.9	− .875	−198	+ .0039	+ .08
4801	+ .0136	1.0	− .875	−198	+ .0019	+ .04
5585	+ .0232	0.7	+ .549	+ 55	− .0025	− .04
5632	+ .0202	1.0	+ .314	+ 72	+ .0003	+ .01
5633	+ .0204	1.0	+ .314	+ 72	+ .0001	.00
5848	+ .0222	0.9	− .737	+147	− .0024	− .05
5849	+ .0168	0.9	− .737	+147	+ .0030	+ .06
7332	+ .0258	0.9	+ .660	+411	− .0008	− .01
7333	+ .0243	0.9	+ .660	+411	+ .0007	+ .01
7334	+ .0288	0.7	+ .660	+411	− .0038	− .07
7358	+ .0226	1.0	+ .637	+413	+ .0024	+ .05
7359	+ .0258	0.9	+ .637	+413	− .0008	− .01
8136	+ .0267	0.9	− .881	+534	− .0027	− .05
8137	+ .0252	1.0	− .881	+534	− .0012	− .02
8162	+ .0242	1.0	− .901	+541	− .0001	.00
8163	+0.0233	1.0	−0.901	+541	+0.0008	+0.02

The normal equations are:

$$19.7c + 6.056\mu - 4.4987\pi = +0.3784 \text{ mm.}$$
$$+ 476.5636\mu + 16.5609\pi = +0.6968 \text{ mm.}$$
$$+ 10.0792\pi = -0.0513 \text{ mm.}$$

from which:

$c = +0.01921$ mm.

$\mu = +0.00116$ mm. $= +0''.0242$, or $+0''.088$ per year.

$\pi = +0.00157$ mm. $= +\mathbf{0''.033 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00142 \text{ mm.} = \pm 0''.030.$$

γ PISCIUM ($23^h\ 12^m$; $+2°\ 44'$)

This is a Ko type star, of magnitude 3.85, and of total proper motion 0″.0753. The Yale heliometer by Chase gave the parallax − 0″.05 ± 0″.044, the photographic value of Allegheny is + 0″.018 ± 0″.010, while the spectroscopic result of Adams is + 0″.022. Mr. Olivier measured the McCormick plates finding a proper motion in right ascension of + 0″.748 while the corresponding value from Boss is + 0″.752. The McCormick parallax is + 0″.044 ± 0″.010.

TABLE 1

PLATES OF γ PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
2086	1915 Nov. 29	−0h9	Ol	0.9
2087	Nov. 29	−0.4	Ol, M	0.9
2111	Dec. 6	−0.6	Ol	0.8
2112	Dec. 6	−0.1	Ol	0.7
4275	1917 Aug. 17	−0.2	A	0.9
4296	Aug. 19	+0.7	Ol	0.7
4316	Aug. 21	+0.4	Ol	0.8
4317	Aug. 21	+0.9	Ol	0.9
4338	Aug. 25	+0.6	Ol	0.9
4339	Aug. 25	+1.1	Ol	1.0
4812	Nov. 26	0.0	B	1.0
4813	Nov. 26	+0.6	B	1.0
4855	Dec. 10	+0.3	M	0.8
4856	Dec. 10	+0.8	M, A	0.8
4863	Dec. 14	+0.4	Ol	0.7*
4864	Dec. 14	+0.8	Ol	0.9
5547	1918 July 13	−0.3	Ol	0.9
5548	July 13	+0.2	Ol	0.9
5580	July 21	+0.4	A	0.9
5581	July 21	+0.9	A	0.7*
6074	Dec. 6	+0.4	H	0.8
6173	1919 Jan. 6	+1.7	D	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR γ PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2086	−0.0589	0.9	−0.893	−651	−0.0020	−0″.04
2087	− .0624	0.9	− .893	−651	+ .0015	+ .03
2111	− .0556	0.8	− .906	−644	− .0046	− .09
2112	− .0623	0.7	− .906	−644	+ .0021	+ .04
4275	+ .0047	0.9	+ .357	− 24	− .0012	− .02
4296	+ .0024	0.7	+ .327	− 22	+ .0012	+ .02
4316	+ .0036	0.8	+ .297	− 20	+ .0001	.00
4317	+ .0027	0.9	+ .297	− 20	+ .0010	+ .02
4338	+ .0041	0.9	+ .237	− 16	− .0001	.00
4339	+ .0026	1.0	+ .237	− 16	+ .0014	+ .03
4812	+ .0121	1.0	− .885	+ 77	− .0013	− .03
4813	+ .0078	1.0	− .885	+ 77	+ .0030	+ .06
4855	+ .0106	0.8	− .907	+ 91	+ .0015	+ .03
4856	+ .0113	0.8	− .907	+ 91	+ .0008	+ .01
4863	+ .0108	0.7	− .903	+ 95	+ .0017	+ .03
4864	+ .0113	0.9	− .903	+ 95	+ .0012	+ .02
5547	+ .0348	0.9	+ .777	+306	+ .0020	+ .04
5548	+ .0389	0.9	+ .777	+306	− .0021	− .04
5580	+ .0396	0.9	+ .701	+314	− .0022	− .04
5581	+ .0363	0.7	+ .701	+314	+ .0011	+ .02
6074	+ .0487	0.8	− .906	+452	− .0010	− .02
6173	+0.0540	1.0	−0.797	+483	−0.0031	−0.06

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.13	−36.4	−12.4	+0.1847
2	.15	−23.8	−11.5	.1904
3	.14	−20.2	− 9.3	.1919
4	.12	+ 2.6	+39.1	.1950
5	.23	+77.8	− 5.9	+0.2380
Parallax star	0.14	+ 3.9	0.0	

The normal equations are:

$$18.9c + 1.102\mu - 5.1286\pi = + 0.0957 \text{ mm.}$$
$$+ 214.9548\mu + 15.5355\pi = + 2.1542 \text{ mm.}$$
$$+ 10.4651\pi = + 0.1489 \text{ mm.}$$

from which:

$c = + 0.00506$ mm.

$\mu = + 0.00984$ mm. $= + 0''.2048$, or $+ 0''.748$ per year.

$\pi = + 0.00209$ mm. $= + \mathbf{0''.044 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00130 \text{ mm.} = \pm 0''.027.$$

LALANDE 45585 ($23^h\ 12^m$; $-2°\ 4'$)

This is a binary β 79 with components separated by 1″, and a period approximating 100 years. The magnitudes are 8.6 and 9.2. Mr. Olivier measured the plates and found a parallax $+ 0''.025 \pm 0''.013$ with a proper motion in right ascension $+ 0''.235$ where the corresponding value from Porter is $+ 0''.249$.

TABLE 1

PLATES OF LALANDE 45585

No.	Date.	Hour Angle.	Observers.	Weight.
3479	1916 Dec. 5	+0^{h}5	L	1.0
3483	Dec. 6	+0.6	Ol	1.0
3484	Dec. 6	+1.0	Ol	1.0
3528	Dec. 17	+0.2	M	0.9
4148	1917 June 30	−0.7	Ol	0.8
4181	July 27	+0.7	B	0.7
4218	July 31	+0.3	Ol	0.6
4219	July 31	+0.6	Ol	0.8
4603	Oct. 20	0.0	Ds	0.8
4604	Oct. 20	+0.3	Ds	0.8
4859	Dec. 12	+0.6	M	0.8
5601	1918 Aug. 5	+0.2	A	0.9
5602	Aug. 5	+0.5	A	1.0
5617	Aug. 11	+0.2	A	1.0
5623	Aug. 13	+0.1	A	0.9
5624	Aug. 13	+0.5	A	0.9
5974	Nov. 14	+0.7	C	0.7
5975	Nov. 14	+1.0	C	0.9
6149	Dec. 29	+0.8	M	0.9
6150	Dec. 29	+1.1	M	1.0
7405	1919 Aug. 2	−0.1	Ol	0.7
7406	Aug. 2	+0.3	Ol	0.8
7425	Aug. 4	−0.8	F	1.0

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.12	−39.5	+51.8	+0.1734
2	.11	−35.4	−30.2	.1411
3	.12	+27.2	−36.5	.3027
4	.11	+47.7	+14.9	+0.3832
Parallax star	0.12	+14.6	− 0.6	

TABLE 2

REDUCTIONS FOR LALANDE 45585

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3479	−0.0084	1.0	−0.905	−471	−0.0043	−0″.09
3483	− .0163	1.0	− .906	−470	+ .0036	+ .07
3484	− .0120	1.0	− .906	−470	− .0006	− .01
3528	− .0104	0.9	− .896	−459	− .0019	− .04
4148	− .0032	0.8	+ .871	−264	− .0009	− .02
4181	− .0036	0.7	+ .634	−237	.0000	.00
4218	− .0040	0.6	+ .586	−233	+ .0005	+ .01
4219	− .0029	0.8	+ .586	−233	− .0006	− .01
4603	− .0042	0.8	− .587	−152	+ .0018	+ .03
4604	− .0026	0.8	− .587	−152	+ .0002	.00
4859	− .0036	0.8	− .905	− 99	+ .0024	+ .05
5601	+ .0051	0.9	+ .527	+137	+ .0028	+ .05
5602	+ .0086	1.0	+ .527	+137	− .0007	− .01
5617	+ .0070	1.0	+ .446	+143	+ .0010	+ .02
5623	+ .0039	0.9	+ .418	+145	+ .0041	+ .08
5624	+ .0107	0.9	+ .418	+145	− .0027	− .05
5974	+ .0122	0.7	− .822	+238	− .0028	− .05
5975	+ .0083	0.9	− .822	+238	+ .0011	+ .02
6149	+ .0078	0.9	− .850	+283	+ .0029	+ .06
6150	+ .0130	1.0	− .850	+283	− .0023	− .05
7405	+ .0142	0.7	+ .568	+499	+ .0050	+ .09
7406	+ .0232	0.8	+ .568	+499	− .0040	− .07
7425	+0.0226	1.0	+0.543	+501	−0.0034	−0.07

The normal equations are:

$$19.9c - 0.175\mu - 2.5611\pi = + 0.0563 \text{ mm.}$$
$$+ 203.0398\mu + 16.1936\pi = + 0.6477 \text{ mm.}$$
$$+ 10.0325\pi = + 0.0547 \text{ mm.}$$

from which:

$c = + 0.00301$ mm.

$\mu = + 0.00310$ mm. $= + 0''.0644$, or $+ 0''.235$ per year.

$\pi = + 0.00122$ mm. $= + \mathbf{0''.025} \pm \mathbf{0''.013}$.

Probable error of plate of unit weight

$$\pm 0.00175 \text{ mm.} = \pm 0''.036.$$

WEISSE xxiii.175 ($23^h\ 13^m$; $-14°\ 21'$)

This is β 182, and according to Burnham, "is undoubtedly a binary, and one of more than ordinary interest from the large proper motion of the system," the proper motion amounting to 1".30 per year in position angle 200°. The only value of the parallax that has been published for the star is the result of measurements with the meridian circle by Flint who gives $\pi = -0''.048 \pm 0''.050$. Mr. Mitchell measured the McCormick plates, and found a relative parallax of $+0''.028 \pm 0''.007$, with a proper motion in right ascension of $-0''.534$, while the value from Porter is $-0''.490$.

TABLE 1

PLATES OF W xxiii.175

No.	Date.	Hour Angle.	Observers.	Weight.
138	1914 July 18	$-0^h.1$	M	0.5
144	July 19	−0.8	M	1.0
150	July 21	−0.4	M	0.8
151	July 21	0.0	M	0.7
452	Oct. 31	+0.8	A, M	1.0
472	Nov. 2	+0.5	M	0.7
529	Nov. 9	+1.1	Ol	0.6
592	Nov. 19	+0.5	A, Ol	1.0
662	Dec. 14	+0.1	Ol	0.5*
672	Dec. 15	−0.1	M	1.0
684	Dec. 17	+0.2	Ol	0.9
1475	1915 July 16	−0.2	G	0.8
1476	July 16	+0.2	G	0.8
1520	Aug. 2	+0.1	Ol	0.8
1530	Aug. 6	0.0	G	0.8
3446	1916 Nov. 27	0.0	M	0.8
3447	Nov. 27	+0.4	M, Ol	0.9
3472	Dec. 2	−0.4	M	0.9

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.25	−77.4	−30.5	+0.2400
2	.19	− 3.7	+31.3	.3169
3	.33	+31.9	+ 7.6	.2439
4	.18	+49.2	− 8.4	+0.1992
Parallax star	0.23	− 2.2	+ 2.8	

TABLE 2

REDUCTIONS FOR W xxiii.175

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
138	+0.0227	0.5	+0.731	−268	−0.0035	−0″.05
144	+ .0182	1.0	+ .722	−267	+ .0009	+ .02
150	+ .0183	0.8	+ .701	−265	+ .0006	+ .01
151	+ .0200	0.7	+ .701	−265	− .0011	− .02
452	+ .0102	1.0	− .706	−163	− .0003	− .01
472	+ .0118	0.7	− .726	−161	− .0021	− .04
529	+ .0066	0.6	− .787	−154	+ .0025	+ .04
592	+ .0072	1.0	− .853	−144	+ .0011	+ .02
662	+ .0077	0.5	− .903	−119	− .0012	− .02
672	+ .0070	1.0	− .902	−118	− .0006	− .01
684	+ .0054	0.9	− .897	−116	+ .0009	+ .02
1475	− .0060	0.8	+ .753	+ 95	− .0003	− .01
1476	− .0075	0.8	+ .753	+ 95	+ .0012	+ .02
1520	− .0094	0.8	+ .567	+112	+ .0016	+ .03
1530	− .0072	0.8	+ .514	+116	− .0009	− .02
3446	− .0417	0.8	− .889	+595	− .0020	− .04
3447	− .0454	0.9	− .889	+595	+ .0018	+ .04
3472	−0.0433	0.9	−0.905	+600	−0.0007	−0.01

The normal equations are:

$$14.5c + 2.934\mu - 2.8174\pi = -0.0338 \text{ mm.}$$
$$+ 128.6415\mu - 10.9808\pi = -0.9206 \text{ mm.}$$
$$+ 8.8941\pi = +0.0908 \text{ mm.}$$

from which:

$c = -0.00065$ mm.
$\mu = -0.00703$ mm. $= -0''.1462$, or $-0''.534$ per year.
$\pi = +0.00133$ mm. $= +0''.028 \pm 0''.007$.

Probable error of plate of unit weight

$$\pm 0.00093 \text{ mm.} = \pm 0''.019.$$

LALANDE 45638 ($23^h\ 14^m$; $+4°\ 52'$)

This is β 80, discovered by Burnham with the 6-inch. According to him, it is "one of the most interesting binaries from the rapid relative motion, and from the large movement of the system in space." The total proper motion amounts to $0''.51$. According to Aitken (*Publications Lick Observatory*, **12**, 179, 1914), "the measures do not define the apastrom end of the apparent ellipse, hence no reliable orbit can as yet be computed." The principal star is of 8.2 magnitude. Mr. Mitchell measured the McCormick plates, and found the small parallax of $+0''.005 \pm 0''.007$, with a proper motion in right ascension amounting to $+0''.487$. The relative parallax by photography at Yerkes is $-0''.001 \pm 0''.009$, while the absolute value by the spectroscope is $+0''.044$.

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−68.2	+ 7.0	+0.120
2	.11	− 1.9	+ 7.4	.168
3	.13	+ 2.4	+11.4	.173
4	.20	+ 3.2	−34.7	.155
5	.18	+ 3.7	−37.9	.155
6	.20	+60.8	+46.8	+0.229
Parallax star	0.24	+ 7.0	+ 3.5	

TABLE 1

PLATES OF LALANDE 45638

No.	Date.	Hour Angle.	Observers.	Weight.
157	1914 July 22	−0ʰ5	Ol	0.7
494	Nov. 4	+0.3	G	1.0
511	Nov. 5	0.0	M	1.0
552	Nov. 11	+0.2	M, G	1.0
583	Nov. 17	+0.1	A	1.0
601	Nov. 21	+0.2	A	1.0
673	Dec. 15	+0.4	M	0.8
685	Dec. 17	+0.8	Ol	0.7
1504	1915 July 23	+0.2	G	1.0
1505	July 23	+0.6	G	0.4
1543	Aug. 12	−0.2	G	0.7
2063	Nov. 25	−0.1	M	0.8
2064	Nov. 25	+0.5	A	0.9
2095	Nov. 30	0.0	M	0.5*
2105	Dec. 4	−0.2	M	0.5*
2176	Dec. 19	+0.3	M	0.9
2836	1916 July 29	+0.1	A	0.7
2837	July 29	+0.6	A	0.7
2918	Aug. 25	+0.1	A	1.0
2919	Aug. 25	+0.5	A	0.8

* One exposure.

The normal equations are:

$$16.1c - 0.880\mu - 5.4440\pi = + 0.9917 \text{ mm.}$$
$$+ 103.1167\mu + 11.9155\pi = + 0.6102 \text{ mm.}$$
$$+ 8.9443\pi = - 0.2589 \text{ mm.}$$

from which:

$c = + 0.06203$ mm.

$\mu = + 0.00642$ mm. $= + 0''.1335$, or $+ 0''.487$ per year.

$\pi = + 0.00026$ mm. $= + 0''.005 \pm 0''.007$.

Probable error of plate of unit weight

$$\pm 0.00080 \text{ mm.} = \pm 0''.017.$$

TABLE 2

REDUCTIONS FOR LALANDE 45638

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
157	+0.0369	0.7	+0.696	−364	+0.0019	+0″.03
494	+ .0448	1.0	− .739	−259	+ .0004	+ .01
511	+ .0469	1.0	− .748	−258	− .0016	− .03
552	+ .0466	1.0	− .798	−252	− .0010	− .02
583	+ .0471	1.0	− .838	−246	− .0011	− .02
601	+ .0454	1.0	− .860	−242	+ .0009	+ .02
673	+ .0486	0.8	− .902	−218	− .0008	− .01
685	+ .0454	0.7	− .898	−216	+ .0025	+ .04
1504	+ .0628	1.0	+ .688	+ 2	− .0005	− .01
1505	+ .0620	0.4	+ .688	+ 2	+ .0003	.00
1543	+ .0649	0.7	+ .442	+ 22	− .0013	− .01
2063	+ .0704	0.8	− .858	+127	− .0004	− .01
2064	+ .0694	0.9	− .858	+127	+ .0006	+ .01
2095	+ .0713	0.5	− .894	+132	− .0010	− .01
2105	+ .0675	0.5	− .902	+136	+ .0030	+ .04
2176	+ .0716	0.9	− .894	+151	− .0001	.00
2836	+ .0878	0.7	+ .612	+374	− .0016	− .03
2837	+ .0852	0.7	+ .612	+374	+ .0010	+ .02
2918	+ .0885	1.0	+ .241	+401	− .0007	− .01
2919	+0.0864	0.8	+0.241	+401	+0.0014	+0.03

ι PEGASI ($23^h\ 20^m$; +22° 51′)

The Allegheny value of the parallax of this star is of Go type, of magnitude 4.62, and of total proper motion 0″.19 is + 0″.033 ± 0″.009, while the absolute parallax of Adams by the spectrograph is + 0″.021. Mr. Lamb measured the photographs with the exception of the last six plates which were measured by Mr. Mitchell. The proper motion in right ascension found by Boss is + 0″.189 per year while the result from the photographs is + 0″.194.

TABLE 1

PLATES OF υ PEGASI

No.	Date.	Hour Angle.	Observers.	Weight.
2074	1915 Nov. 27	$-0^h.3$	M	0.9
2075	Nov. 27	0.0	G	0.7
2157	Dec. 14	+0.4	M	0.7
2213	Dec. 23	+0.2	M	0.7
2831	1916 July 20	−0.7	L	0.5*
2832	July 20	−0.3	L	0.7
2893	Aug. 18	−0.5	A	0.9
2894	Aug. 18	−0.2	A	1.0
2941	Aug. 30	+0.2	A	1.0
3372	Nov. 8	0.0	Ol	1.0
3373	Nov. 8	+0.4	Ol	1.0
3383	Nov. 16	−0.9	L	1.0
3384	Nov. 16	−0.6	L	1.0
4188	1917 July 28	−0.4	B	0.7
4189	July 28	−0.1	B	0.8
4199	July 29	+0.4	Ol	0.8
4200	July 29	+0.8	Ol	0.6*
4656	Oct. 31	+0.2	B	1.0
4657	Oct. 31	+0.6	B	1.0

* One exposure.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.19	−50.3	−29.4	+0.2810
2	.20	−10.2	+15.2	.2105
3	.16	− 6.0	−14.0	.2764
4	.13	+66.5	+28.2	+0.2321
Parallax star	0.17	− 2.5	− 2.4	

TABLE 2

REDUCTIONS FOR v PEGASI

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2074	+0.0010	0.9	−0.877	−346	−0.0016	−0″.03
2075	− .0021	0.7	− .877	−346	+ .0015	+ .02
2157	+ .0011	0.7	− .904	−329	− .0013	− .02
2213	− .0027	0.7	− .886	−320	+ .0027	+ .05
2831	+ .0055	0.5	+ .729	−110	+ .0005	+ .01
2832	+ .0071	0.7	+ .729	−110	− .0011	− .02
2893	+ .0044	0.9	+ .372	− 81	+ .0022	+ .04
2894	+ .0060	1.0	+ .372	− 81	+ .0006	+ .01
2941	+ .0080	1.0	+ .193	− 69	− .0012	− .02
3372	+ .0086	1.0	− .762	+ 1	− .0003	− .01
3373	+ .0072	1.0	− .762	+ 1	+ .0011	+ .02
3383	+ .0118	1.0	− .823	+ 9	− .0034	− .07
3384	+ .0076	1.0	− .823	+ 9	+ .0008	+ .02
4188	+ .0171	0.7	+ .647	+263	− .0016	− .03
4189	+ .0132	0.8	+ .647	+263	+ .0023	+ .04
4199	+ .0154	0.8	+ .636	+264	+ .0001	.00
4200	+ .0180	0.6	+ .636	+264	− .0025	− .04
4656	+ .0178	1.0	− .685	+358	− .0004	− .01
4657	+0.0158	1.0	−0.685	+358	+0.0016	+0.03

The normal equations are:

$$16.0c + 1.373\mu - 3.5607\pi = + 0.1384 \text{ mm.}$$
$$+ 82.8561\mu + 7.0888\pi = + 0.2259 \text{ mm.}$$
$$+ 7.9387\pi = - 0.0094 \text{ mm.}$$

from which:

$c = + 0.00851$ mm.

$\mu = + 0.00255$ mm. $= + 0''.0531$, or $+ 0''.194$ per year.

$\pi = + 0.00035$ mm. $= + \mathbf{0''.007 \pm 0''.009}$.

Probable error of plate of unit weight

$$\pm 0.00111 \text{ mm.} = \pm 0''.023.$$

ι PISCIUM ($23^h\ 34^m$; $+5°\ 5'$)

This star of 4.28 magnitude and F5 type has a considerable proper motion 0".574 per year. The parallax has been measured as follows: from the Yale heliometer + 0".138 ± 0".059, from the meridian circle by Jewdokimov + 0".100 ± 0".100, and by the spectrograph by Mt. Wilson + 0".083. Mr. Alden measured the plates and found a parallax + 0".067 + 0".007 with the proper motion in right ascension + 0".361 where the value from Boss is + 0".370.

TABLE 1

PLATES OF ι PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
3509	1916 Dec. 8	−0h3	M	0.9
3535	Dec. 19	−0.2	M	0.8
4206	1917 July 30	+0.3	A	0.9
4207	July 30	+0.7	A	0.9
4822	Nov. 28	+0.5	A	0.9
4879	Dec. 15	+0.1	M	0.8
4893	Dec. 21	+0.4	Ol	0.7
5560	1918 July 14	−0.4	A	0.6*
5586	Aug. 2	+0.1	A	0.9
5587	Aug. 2	+0.5	A	0.9
5612	Aug. 6	+0.2	A	1.0
5613	Aug. 6	+0.6	A	1.0
5852	Nov. 2	+0.8	F, M	0.9
5853	Nov. 2	+1.3	F, M	1.0
6099	Dec. 18	+0.3	M	0.9
7426	1919 Aug. 4	−0.7	F	0.8
7427	Aug. 4	−0.2	F	0.7
7430	Aug. 5	−0.4	H	1.0
7431	Aug. 5	0.0	H	0.9
7502	Aug. 18	−1.0	D	0.8
8021	Nov. 6	−0.4	A	1.0
8056	Nov. 14	0.0	A	1.0

* One exposure.

TABLE 2

REDUCTIONS FOR ι PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
3509	+0.0258	0.9	−0.898	−623	−0.0018	−0″.04
3535	+ .0234	0.8	− .901	−612	+ .0011	+ .02
4206	+ .0406	0.9	+ .669	−389	− .0004	− .01
4207	+ .0415	0.9	+ .669	−389	− .0013	− .03
4822	+ .0404	0.9	− .865	−268	+ .0006	+ .01
4879	+ .0438	0.8	− .904	−251	− .0021	− .04
4893	+ .0415	0.7	− .898	−245	+ .0005	+ .01
5560	+ .0562	0.6	+ .819	− 40	+ .0010	+ .02
5586	+ .0568	0.9	+ .638	− 21	+ .0008	+ .01
5587	+ .0558	0.9	+ .638	− 21	+ .0018	+ .04
5612	+ .0562	1.0	+ .591	− 17	+ .0014	+ .03
5613	+ .0580	1.0	+ .591	− 17	− .0004	− .01
5852	+ .0579	0.9	− .660	+ 71	− .0001	.00
5853	+ .0556	1.0	− .660	+ 71	+ .0022	+ .05
6099	+ .0578	0.9	− .902	+117	+ .0014	+ .03
7426	+ .0757	0.8	+ .618	+346	− .0007	− .01
7427	+ .0742	0.7	+ .618	+346	+ .0008	+ .01
7430	+ .0781	1.0	+ .606	+347	− .0031	− .06
7431	+ .0728	0.9	+ .606	+347	+ .0022	+ .04
7502	+ .0770	0.8	+ .439	+360	− .0020	− .04
8021	+ .0753	1.0	− .699	+440	− .0001	.00
8056	+0.0764	1.0	−0.772	+448	−0.0011	−0.02

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.14	−26.4	−36.0	+0.2275
2	.12	−16.5	+68.2	.2918
3	.11	+42.9	−32.2	+0.4807
Parallax star	0.14	+ 9.8	− 3.8	

The normal equations are:

$$19.3c + 1.347\mu - 0.7405\pi = + 1.0947 \text{ mm.}$$
$$+ 200.8954\mu + 9.6579\pi = + 1.0629 \text{ mm.}$$
$$+ 9.9754\pi = + 0.0362 \text{ mm.}$$

from which:

$c = + 0.05651$ mm.
$\mu = + 0.00476$ mm. $= + 0''.0989$, or $+ 0''.361$ per year.
$\pi = + 0.00322$ mm. $= + \mathbf{0''.067 \pm 0''.007}$.

Probable error of plate of unit weight

$$\pm 0.00100 \text{ mm.} = + 0''.021.$$

BOSS 6129 ($23^h\ 47^m$; $+ 74°\ 59'$)

This star of magnitude 6.55 and of magnitude K has the total proper motion $0''.332$. The only trigonometric parallax is the photographic result of van Maanen $+ 0''.097 \pm 0''.004$. The spectrographic value of Mt. Wilson is $+ 0''.105$. Miss Darkow measured the McCormick plates and found the relative parallax $+ 0''.088 \pm 0''.008$ with a proper motion in right ascension $+ 0''.315$ where the corresponding value from Boss is $+ 0''.329$.

TABLE 1

PLATES OF BOSS 6129

No.	Date.	Hour Angle.	Observers.	Weight.
4845	1917 Dec. 5	$-0^h.5$	M, A	0.8
4850	Dec. 6	−0.7	M	1.0
4851	Dec. 6	−0.4	M	1.0
4883	Dec. 20	−0.1	M	1.0
5626	1918 Aug. 14	−0.2	A	1.0
5627	Aug. 14	+0.2	A	1.0
5634	Aug. 19	−0.3	A	1.0
5635	Aug. 19	+0.1	A	1.0
5850	Nov. 2	−0.4	F	0.7
5851	Nov. 2	0.0	M	1.0
5877	Nov. 5	−0.8	H	1.0
5878	Nov. 5	0.0	D	0.9
7325	1919 July 23	−0.6	D	0.9
7326	July 23	−0.2	D	0.6
7346	July 25	0.0	F	1.0
7347	July 25	+0.4	F	1.0
8198	Dec. 4	−0.6	A	1.0
8199	Dec. 4	−0.2	A	1.0
8200	Dec. 4	+0.1	A	1.0

COMPARISON STARS

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.17	−32.4	−39.6	+0.275
2	.10	−23.1	+20.5	.246
3	.10	−19.6	+15.1	.247
4	.15	+75.1	+ 4.0	+0.232
Parallax star	0.13	− 2.0	− 1.2	

TABLE 2

REDUCTIONS FOR BOSS 6129

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
4845	−0.0218	0.8	−0.879	−365	+0.0025	+0″.05
4850	− .0168	1.0	− .882	−364	− .0025	− .05
4851	− .0228	1.0	− .882	−364	+ .0035	+ .07
4883	− .0166	1.0	− .902	−350	− .0022	− .05
5626	− .0024	1.0	+ .536	−113	− .0004	− .01
5627	− .0041	1.0	+ .536	−113	+ .0013	+ .03
5634	− .0020	1.0	+ .470	−108	− .0009	− .02
5635	− .0016	1.0	+ .470	−108	− .0013	− .03
5850	− .0056	0.7	− .621	− 33	+ .0012	+ .02
5851	− .0034	1.0	− .621	− 33	− .0010	− .02
5877	− .0044	1.0	− .654	− 30	− .0001	.00
5878	− .0045	0.9	− .654	− 30	.0000	.00
7325	+ .0119	0.9	+ .777	+230	+ .0005	+ .01
7326	+ .0142	0.6	+ .777	+230	− .0018	− .03
7346	+ .0116	1.0	+ .759	+232	+ .0008	+ .02
7347	+ .0115	1.0	+ .759	+232	+ .0009	+ .02
8198	+ .0112	1.0	− .873	+364	− .0002	.00
8199	+ .0124	1.0	− .873	+364	− .0014	− .03
8200	+0.0096	1.0	−0.873	+364	+0.0014	+0.03

The normal equations are:

$$17.9c - 0.241\mu - 3.5910\pi = -0.0240 \text{ mm.}$$
$$+ 113.0985\mu + 7.3085\pi = +0.5008 \text{ mm.}$$
$$+ 9.8163\pi = +0.0736 \text{ mm.}$$

from which.

$c = -0.00043$ mm.

$\mu = +0.00415$ mm. $= +0''.0864$, or $+0''.315$ per year.

$\pi = +0.00425$ mm. $= +\mathbf{0''.088} \pm \mathbf{0''.008}$.

Probable error of plate of unit weight

$$\pm 0.00110 \text{ mm.} = \pm 0''.023.$$

ρ CASSIOPEIÆ ($23^h\ 49^m$; $+56°\ 57'$)

The Allegheny parallax for this star is $+ 0''.013 \pm 0''.011$, while the absolute value of Adams by the spectrograph is $+ 0''.008$. The star is of 4.85 magnitude, of F8p type, and of very small proper motion $0''.007$ per year. Mr. Alden measured the plates, and found a proper motion in right ascension amounting to $- 0''.028$ per year, while the value from Boss is $- 0''.005$.

TABLE 1

PLATES OF ρ CASSIOPEIÆ AND BOSS 6142

No.	Date.	Hour Angle.	Observers.	Weight.
2088	1915 Nov. 29	-0^h2	G	0.8
2128	Dec. 8	−0.3	M	1.0
2129	Dec. 8	0.0	M	0.9
2225	Dec. 24	−0.2	Ol	0.8
2227	Dec. 26	0.0	M	0.8
2854	1916 Aug. 7	−0.8	A	0.9
2855	Aug. 7	−0.4	A	1.0
2863	Aug. 12	−0.3	A	0.9
2927	Aug. 26	−0.5	Ol	0.9
2928	Aug. 26	−0.1	Ol	0.5*
3385	Nov. 16	−0.6	L	1.0
3386	Nov. 16	−0.1	L	1.0
3415	Nov. 20	−0.4	A	1.0
3416	Nov. 20	0.0	A	1.0
4204	1917 July 30	−0.9	A	0.7
4205	July 30	−0.6	A	1.0
4246	Aug. 5	−0.6	A	1.0
4247	Aug. 5	−0.4	A	1.0
4787	Nov. 18	−0.7	B	1.0
4788	Nov. 18	−0.3	B	1.0
4793	Nov. 19	−1.0	A	0.9
4794	Nov. 19	−0.7	A	0.9
4820	Nov. 28	−0.6	M	1.0
4821	Nov. 28	−0.2	A	0.9

* One exposure.

COMPARISON STARS FOR ρ CASSIOPEIÆ

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−73.9	− 7.1	+0.2086
2	.13	−61.8	+39.9	.2060
3	.10	+25.7	−51.8	.1982
4	.12	+39.9	+32.4	.1948
5	.13	+70.1	−13.4	+0.1924
Parallax star	0.15	− 1.8	+ 0.2	

TABLE 2

REDUCTIONS FOR ρ CASSIOPEIÆ

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2088	−0.0012	0.8	−0.847	−399	−0.0002	0″.00
2128	− .0028	1.0	− .885	−390	+ .0012	+ .02
2129	− .0051	0.9	− .885	−390	+ .0036	+ .07
2225	− .0028	0.8	− .900	−374	+ .0012	+ .02
2227	− .0023	0.8	− .896	−372	+ .0007	+ .01
2854	− .0006	0.9	+ .622	−147	+ .0011	+ .02
2855	+ .0017	1.0	+ .622	−147	− .0012	− .02
2863	+ .0037	0.9	+ .562	−142	− .0033	− .06
2927	− .0003	0.9	+ .373	−128	+ .0003	+ .01
2928	+ .0011	0.5	+ .373	−128	− .0011	− .02
3385	− .0049	1.0	− .760	− 46	+ .0023	+ .05
3386	.0000	1.0	− .760	− 46	− .0026	− .05
3415	+ .0013	1.0	− .793	− 42	− .0040	− .08
3416	+ .0009	1.0	− .793	− 42	− .0036	− .07
4204	− .0020	0.7	+ .712	+210	+ .0014	+ .02
4205	− .0030	1.0	+ .712	+210	+ .0024	+ .05
4246	+ .0010	1.0	+ .648	+216	− .0018	− .04
4247	− .0027	1.0	+ .648	+216	+ .0019	+ .04
4787	− .0065	1.0	− .775	+321	+ .0025	+ .05
4788	− .0046	1.0	− .775	+321	+ .0006	+ .01
4793	− .0022	0.9	− .783	+322	− .0018	− .04
4794	− .0015	0.9	− .783	+322	− .0025	− .05
4820	− .0050	1.0	− .844	+331	+ .0008	+ .02
4821	−0.0063	0.9	−0.844	+331	+0.0021	+0.04

The normal equations are:

$$21.9c + 2.202\mu - 6.7487\pi = -0.0416 \text{ mm.}$$
$$+ 149.8022\mu + 3.3817\pi = -0.0522 \text{ mm.}$$
$$+ 12.3392\pi = +0.0317 \text{ mm.}$$

from which:

$c = -0.00125$ mm.
$\mu = -0.00037$ mm. $= -0''.0078$, or $-0''.028$ per year.
$\pi = +0.00199$ mm. $= +\mathbf{0''.041 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00148 \text{ mm.} = \pm 0''.031.$$

BOSS 6142 ($23^h\ 50^m$; $+56°\ 51'$)

This star of 6.2 magnitude, and of small proper motion $0''.01$, is $8'.9$ preceding, and $5'.2$ south of ρ Cassiopeiæ. Its parallax was determined by Mr. Alden from the same series of plates as were used for ρ Cassiopeiæ. The proper motion in right ascension found by him amounts to $-0''.008$ per year while the value from Boss is $-0''.005$.

TABLE 1

COMPARISON STARS FOR BOSS 6142

No.	Diameter.	*X* (Right Ascension).	*Y* (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.10	−101.3	0.0	+0.1992
3	.10	− 1.8	−44.7	.2930
4	.12	+ 12.4	+39.5	.1179
5	.13	+ 42.6	− 6.4	.2136
6	.10	+ 48.1	+11.6	+0.1763
Parallax star	0.07	− 1.7	− 7.8	

TABLE 2

REDUCTIONS FOR BOSS 6142

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
2088	−0.0198	0.8	−0.847	−399	+0.0040	+0″.07
2128	− .0159	1.0	− .885	−390	+ .0001	.00
2129	− .0201	0.9	− .885	−390	+ .0043	+ .08
2225	− .0132	0.8	− .900	−374	− .0027	− .05
2227	− .0146	0.8	− .896	−372	− .0013	− .02
2854	− .0139	0.9	+ .622	−147	− .0004	− .01
2855	− .0153	1.0	+ .622	−147	+ .0010	+ .02
2863	− .0128	0.9	+ .562	−142	− .0016	− .03
2927	− .0110	0.9	+ .373	−128	− .0036	− .07
2928	− .0177	0.5	+ .373	−128	+ .0031	+ .05
3385	− .0150	1.0	− .760	− 46	− .0010	− .02
3386	− .0139	1.0	− .760	− 46	− .0021	− .04
3415	− .0140	1.0	− .793	− 42	− .0021	− .04
3416	− .0156	1.0	− .793	− 42	− .0005	− .01
4204	− .0120	0.7	+ .712	+210	− .0025	− .04
4205	− .0169	1.0	+ .712	+210	+ .0024	+ .05
4246	− .0146	1.0	+ .648	+216	.0000	.00
4247	− .0160	1.0	+ .648	+216	+ .0014	+ .03
4787	− .0193	1.0	− .775	+321	+ .0029	+ .06
4788	− .0182	1.0	− .775	+321	+ .0018	+ .04
4793	− .0190	0.9	− .783	+322	+ .0026	+ .05
4794	− .0134	0.9	− .783	+322	− .0030	− .06
4820	− .0161	1.0	− .844	+331	− .0004	− .01
4821	−0.0145	0.9	−0.844	+331	−0.0020	−0.04

The normal equations are:

$$21.9c + 2.202\mu - 6.7487\pi = -0.3404 \text{ mm.}$$
$$+ 149.8022\mu + 3.3817\pi = -0.0443 \text{ mm.}$$
$$+ 12.3392\pi = +0.1168 \text{ mm.}$$

from which:

$c = -0.01516$ mm.

$\mu = -0.00010$ mm. $= -0''.0021$, or $-0''.008$ per year.

$\pi = +0.00120$ mm. $= +\mathbf{0''.025 \pm 0''.010}$.

Probable error of plate of unit weight

$$\pm 0.00152 \text{ mm.} = \pm 0''.032.$$

ω PISCIUM ($23^h\ 54^m$; $+6°\ 19'$)

The only trigonometric value of the parallax of this star published is the Allegheny result from photography, $-0''.002 \pm 0''.009$.

TABLE 1

PLATES OF ω PISCIUM

No.	Date.	Hour Angle.	Observers.	Weight.
432	1914 Oct. 29	+1h2	M	0.8
438	Oct. 30	+1.0	G	0.8
718	Dec. 27	+0.7	A	0.8
1544	1915 Aug. 12	0.0	G	0.8
1545	Aug. 12	+0.5	G	0.5*
1571	Aug. 23	−0.8	A	1.0
1572	Aug. 23	−0.2	A	0.8
1597	Sept. 1	−0.7	A	1.0
1598	Sept. 1	−0.2	A	1.0
1906	Oct. 29	+1.1	Ol	0.7
2047	Nov. 23	−0.2	G	0.7
2048	Nov. 23	+0.4	G	0.8
2113	Dec. 6	+0.1	M	0.7
2146	Dec. 10	−0.5	Ol	0.5*
3462	1916 Dec. 1	−0.2	M, Ol	0.7
3463	Dec. 1	+0.2	Ol	0.8
3473	Dec. 2	−0.6	M	1.0
3474	Dec. 2	−0.2	A	0.7*

* One exposure.

The spectroscopic parallax is $+0''.046$. The star is of F5 type, of magnitude 4.03, and of total proper motion $0''.19$. Mr. Graham measured the McCormick plates with the exception of the last four plates measured by Mr. Mitchell. The proper motion from the plates amounts to $+0''.135$ per year in right ascension while the value from Boss is $+0''.149$.

COMPARISON STARS

No.	Diameter.	X (Right Ascension).	Y (Declination).	Dependence.
	mm.	mm.	mm.	
1	0.23	−88.4	− 2.6	+0.1447
2	.14	+18.5	−15.2	.2154
3	.18	+18.6	+ 2.9	.2111
4	.13	+23.4	+50.1	.2025
5	.24	+27.9	−35.2	+0.2263
Parallax star	0.21	+ 6.2	− 0.9	

TABLE 2

REDUCTIONS FOR ω PISCIUM

Plate.	Solution (m).	Weight (p).	Parallax Factor (P).	Time in Days (t).	Residual (v).	$\sqrt{p}\cdot v$ in Arc.
	mm.				mm.	
432	+0.0222	0.8	−0.550	−365	−0.0011	−0″.02
438	+ .0190	0.8	− .563	−364	+ .0021	+ .04
718	+ .0214	0.8	− .897	−306	+ .0004	+ .01
1544	+ .0279	0.8	+ .588	− 88	− .0009	− .02
1545	+ .0254	0.5	+ .588	− 88	+ .0016	+ .02
1571	+ .0267	1.0	+ .446	− 67	+ .0005	+ .01
1572	+ .0281	0.8	+ .446	− 67	− .0009	− .02
1597	+ .0254	1.0	+ .317	− 58	+ .0019	+ .04
1598	+ .0292	1.0	+ .317	− 58	− .0019	− .04
1906	+ .0279	0.7	− .530	0	− .0003	.00
2047	+ .0284	0.7	− .800	+ 25	− .0006	− .01
2048	+ .0281	0.8	− .800	+ 25	− .0003	.00
2113	+ .0281	0.7	− .873	+ 38	− .0001	.00
2146	+ .0306	0.5	− .887	+ 42	− .0025	− .04
3462	+ .0310	0.7	− .854	+399	+ .0034	+ .06
3463	+ .0338	0.8	− .854	+399	+ .0006	+ .01
3473	+ .0363	1.0	− .859	+400	− .0018	− .04
3474	+0.0343	0.7	−0.859	+400	+0.0001	0.00

The normal equations are:

$$14.1c + 1.846\mu - 4.7737\pi = + 0.3948 \text{ mm.}$$
$$+ 82.5993\mu - 7.8078\pi = + 0.1922 \text{ mm.}$$
$$+ 6.5796\pi = - 0.1423 \text{ mm.}$$

from which:

$c = +0.02805$ mm.
$\mu = +0.00178$ mm. $= +0''.0370$, or $+0''.135$ per year.
$\pi = +0.00084$ mm. $= +0''.018 \pm 0''.009$.

Probable error of plate of unit weight

$$\pm 0.00095 \text{ mm.} = \pm 0''.020.$$

The average probable error for the 260 McCormick parallaxes is $0''.0091$. This is the same precision attained in the later Yerkes results, and slightly greater than the probable error of the Allegheny parallaxes, both of these observatories employing refractors of greater aperture and also greater focal length than the McCormick telescope. The Allegheny refractor possesses a photographic objective, and as a consequence much shorter exposures are permitted than are necessary for the visual refractors of Yerkes and McCormick Observatories. With the shorter exposures at Allegheny it is unnecessary to photograph when the parallax factor is less than 0.7, and as a result the average plate at Allegheny has a greater parallax factor than a similar plate at Yerkes or McCormick, and consequently a greater weight in the determination of the parallax. The average probable error of a single McCormick plate with two star images of good quality is 0.0013 millimeters, or $0''.027$. On the average 4.5 comparison stars were used.

Comparisons with the Early Parallaxes

With the details which are included in the discussion of each star there is given the parallax measures so far as they have been published.

In the year 1910, there was published in *Groningen Publications* No. 24 by Kapteyn and Weersma a list of all the parallaxes whose determinations were considered reliable. There are 360 stars on the list. 72 of these stars have had their parallaxes determined at the McCormick Observatory. Since these 72 form one fifth of the total list, and should therefore be fairly representative of the whole 360, comparisons will be not without interest. This is found in Table 3, where there is added the number

TABLE 3.

COMPARISON WITH PARALLAXES IN GRONINGEN NO. 24.

Star.	Groningen. Determ.	Groningen. π.	McCormick.	$G-M$.	Star.	Groningen. Determ.	Groningen. π.	McCormick.	$G-M$.
β Cassiop.	3	+″.074	+″.063	+″.011	61 Virginis	1	+″.157	+″.135	+″.022
Pi. 0^h130	1	+.360	+.091	+.269	ζ Urs. Maj.	2	+.033	+.037	−.004
54 Piscium	1	+.154	+.106	+.048	70 Virginis	1	+.149	+.050	+.099
Lal. 1198	1	+.080	+.044	+.036	Lal. 25224	1	+.260	+.029	+.231
η Cassiop.	3	+.201	+.184	+.017	Lal. 25372	4	+.176	+.229	−.053
Lal. 1799	2	+.061	+.027	+.034	Lal. 27173	2	+.172	+.194	−.022
ω Androm.	1	+.088	+.028	+.060	γ Serpentis	3	+.029	+.103	−.074
41 H Androm.	1	+.116	+.097	+.019	α Cor. Bor.	1	+.031	+.061	−.030
τ Ceti	2	+.334	+.317	+.017	η Herculis	2	+.063	+.052	+.011
Lal. 4141	1	+.029	+.039	−.010	μ Herculis	2	+.106	+.113	−.007
δ Triang.	2	+.119	+.132	−.013	γ Draconis	1	+.107	+.005	+.102
o Ceti	1	+.142	+.066	+.076	70 Ophiuchi	2	+.168	+.183	−.015
Pi. 2^h123	2	+.143	+.142	+.001	χ Draconis	1	+.119	+.095	+.024
ρ Persei	1	+.087	+.034	+.053	110 Herculis	1	+.068	+.065	+.003
10 Tauri	1	+.069	+.048	+.021	31 Aquilæ	4	+.065	+.079	−.014
Lal. 6888–9	5	+.055	+.030	+.025	β Cygni	1	−.021	+.002	−.023
o^2 Eridani	2	+.174	+.209	−.035	Lal. 37120	1	+.058	+.047	+.011
α Tauri	4	+.073	+.040	+.033	σ Draconis	3	+.197	+.186	+.011
W. B. 4^h 1189	1	+.302	+.129	+.173	θ Cygni	1	+.066	+.085	−.019
λ Aurigæ	2	+.111	+.069	+.042	16 Cygni	1	+.158	+.038	+.120
W. B. 5^h 592	2	+.182	+.168	+.014	α Aquilæ	2	+.238	+.223	+.015
Groomb. 990	1	+.028	+.029	−.001	Lal. 38287	1	+.088	+.083	+.005
β Aurigæ	2	+.014	+.031	−.017	Lal. 38383	2	+.029	+.080	−.051
η Gemin.	1	+.044	+.004	+.040	γ Cygni	1	+.106	+.002	+.104
Lal. 13427	2	+.051	+.012	+.039	β Delphini	1	−.010	+.013	−.023
ρ Gemin.	1	+.049	+.057	−.008	ϵ Cygni	1	−.182	+.044	−.226
α Gemin	3	+.028	+.081	−.053	η Cephei	1	+.097	+.069	+.028
α Canis Min.	4	+.324	+.314	+.010	61 Cygni	11	+.311	+.312	−.001
Lal. 15290	4	+.045	+.038	−.007	δ Equulei	2	+.067	+.046	+.021
Lal. 16304	1	+.127	+.065	+.062	τ Cygni	1	+.128	+.051	+.077
ρ Cancri	2	+.085	+.081	+.004	κ Pegasi	1	+.028	+.021	+.007
γ Leonis	1	−.035	−.006	−.029	ϵ Cephei	1	+.107	+.058	+.049
Lal. 21258	5	+.203	+.182	+.021	ξ Pegasi	1	+.089	+.051	+.038
β Virginis	1	+.118	+.101	+.017	W. B. 23^h 175	1	+.052	+.033	+.019
Groomb. 1830	6	+.102	+.111	−.009	γ Piscium	1	−.041	+.049	−.090
β Comæ	3	+.116	+.145	−.029	ι Piscium	1	+.148	+.072	+.076

of separate determinations on which the results in Groningen are based. Kapteyn and Weersma have listed the absolute value of the parallaxes. Accordingly in the following table, 0".005 has been added to the McCormick observed values in order to change them from relative to absolute parallaxes.

47 of the differences *Groningen-McCormick* have positive values while only 25 are negative. The average difference *Groningen-McCormick* is + 0".020, but excluding four stars where the differences are very large this average reduces to + 0".015. Apparently, therefore, there appears to be abundant justification for Kapteyn's belief that parallax observers may have a bias in favor of positive parallaxes. With all honesty an observer may decide to abstain from publishing his results where a large negative parallax has been obtained until this parallax has been verified from additional observations. If, on the other hand, the results of the measures furnish a large positive parallax, the star would be regarded as specially interesting on account of its nearness, and there would probably be no apparent reason why the scientific world should not be made acquainted with this discovery through the publication of the parallax.

Among the 72 stars, only two have more than five early determinations, the star Groombridge 1830, where the average parallax from the Groningen tabulation is + 0".102, while the McCormick absolute parallax is + 0".111, and 61 Cygni with the mean value for the pair of + 0".311 and + 0".312, from Groningen and McCormick respectively. For these two stars, well determined by the early observers, there is excellent agreement with the McCormick values. The only series of parallaxes included in the Groningen list which have an accuracy comparable with the present measures are the early Yerkes results of Schlesinger. It is clear, therefore, that the parallax results of the heliometer and meridian circle, on which the Groningen list mainly depends, are on the average too large, and, moreover, are subject to errors which are very large when compared with modern photographic work. A word of caution might not be out of place that one should not put too much reliance on the accuracy of the early parallaxes.

Comparisons with the Yale Heliometer.

The greatest admiration must be felt for the Yale observers for the indefatigable labor involved in the publication of no less than 238 parallaxes. On page 8 there is given the results of 128 observations on the star α Canis Minoris showing values of the parallax which range from $+ 0''.228$ to $+ 0''.503$, with a mean value of $+ 0''.334$. As the seven separate series on this star were made with special care, one can readily see the limitations of the heliometer.

57 stars of the 238 observed at Yale, or one-fifth of the total, have had their parallaxes determined at the McCormick Observatory. A detailed comparison was accordingly made, and differences were formed in the sense, *McCormick-Yale*. In view of what has been said above, it is quite natural to expect large differences. In fact 14 of the 57, or one-quarter of the number, have differences between Yale and McCormick which exceed $0''.050$. For the 43 most accordant stars, the average difference between McCormick and Yale is $0''.019$, but the Yale values on the average are larger than the McCormick results by $0''.0055$. For all of the 57 stars, the average difference between McCormick and Yale is $0''.035$ with the Yale parallaxes larger than the McCormick by the average value of $0''.002$. In the above comparisons, values of the *relative* parallaxes were used. Since Yale employed brighter comparison stars than McCormick, which stars on the average would have larger parallaxes that the fainter McCormick comparison stars, the Yale relative parallaxes in reality should come out smaller in size than the McCormick relative parallaxes, and not larger.

It might not be out of place to again express admiration for the splendid Yale results especially when one considers the short focal length of the heliometer employed. However, some of their parallaxes show considerable deviations from the average of the best photographic work with telescopes of great focal length, and this is specially true where the series of observations on which the parallaxes depended were short.

COMPARISONS WITH MODERN PHOTOGRAPHIC PARALLAXES.

120 stars of the McCormick 260, or nearly one half the total, have had their parallaxes determined by photography with telescopes of great focal length, the telescopes arranged according to their apertures being Mt. Wilson, Yerkes, Allegheny, Greenwich, Swarthmore, and Dearborn. Although the agreement between these photographic authorities is on the whole very satisfactory, still there are individual cases where these modern parallaxes differ among themselves more than one would be led to expect from the size of the probable errors. An instance of this may be seen in the results for the well-known star 61 Cygni. The mean of the values for the two stars of the pair have the following values arranged in order of the size of the parallaxes:

Mt. Wilson	0″.322
McCormick	.307
Swarthmore	.301
Allegheny	.284.
Yerkes	0″.272
Mean	0″.297

Including all determinations of the parallax of this well observed system, the mean parallax weighted according to the probable errors is 0″.306. The extreme range in values of 0″.050 is obtained between that determined by the Mt. Wilson reflector of 60 inches aperture and equivalent focal length of 80 feet and the Yerkes refractor of 40 inches aperture and 62 feet focal length. Apparently, therefore, even from observations carefully made with great telescopes there is still opportunity for occasional differences in parallaxes amounting to several times the size of the probable error. With photographs having the scale of the McCormick plates, 0″.050 is equivalent to 0.0024 mm.

In order to investigate whether there are any systematic errors in the McCormick parallaxes, their values were compared in detail with the results for the 120 stars determined by photography elsewhere. Accordingly the differences were found for each star in the sense *McCormick-Others*. For only twenty out of the 120 stars was the parallax determined by more than one other authority. In each and every one of these 20 stars the agreement

between McCormick and the mean of the other authorities was uniformly good, for in no case did the difference exceed 0".025. For the other 100 stars there was one other photographic authority only. When two authorities are compared and differences are found, it is difficult to know which is in error, or whether both may not be in error. Twelve times altogether, or in ten per cent of the total, the McCormick parallax differed from the other authority by an amount exceeding 0".035, which is approximately four times the probable error.

In testing observations for the purpose of finding systematic errors, when comparisons are made with the average of other results, it is difficult to know how to treat discordances which are large in size. Manifestly a few large differences, if these differences happen to be all positive or all negative, will make the same accumulated difference as a large number of very small differences, each of the same sign. If the comparisons are made between two authorities of equal reliability one had probably best reject the discordant observations. If a third series of values can be found entirely independent of the first two, these results will serve as a test for deciding which of the observations are in error. Such an independent series may be found in the spectroscopic parallaxes determined at Mt. Wilson by Adams and Joy. Accordingly, the McCormick and other photographic parallaxes were compared with the spectroscopic results after 0".005 had been deducted from the spectroscopic values to change them from absolute to relative parallaxes. For the twelve discordant stars, the average difference between McCormick and spectroscopic parallaxes was less than 0".001.

Consequently, for testing the systematic errors of the McCormick parallaxes it will evidently be best that these twelve stars be discarded from the comparisons. For the remaining 108 stars, the average deviation between McCormick and the other photographic authorities is 0".015, while the McCormick parallaxes on the average are the larger by an amount which is less than 0".001. It should be pointed out that since the comparisons in most cases are made with only one other authority it is impossible to tell whether the McCormick parallaxes are too large by this minute quantity, or whether the other authorities are too

small by a like amount. Taking all of the 120 stars in common, the average deviation is 0″.018 while the McCormick results are larger than the other authorities by the average of 0″.0027.

93 stars of the 120, of three-quarters of the whole, were observed by Allegheny and McCormick. Of these 93 stars in common there are eight cases where the difference between McCormick and Allegheny is greater than 0″.035. For the balance of 85 stars, the average deviation between McCormick and Allegheny is 0″.012, while the McCormick values are larger than the Allegheny results by 0″.0006. For the whole 93 stars common to Allegheny and McCormick, the average deviation is 0″.018 while Allegheny is smaller than McCormick by the average amount of 0″.0037.

The Ursa Major Group

Another comparison of interest is that afforded by the stars of the Ursa Major group. In *Astronomische Nachrichten*, 4738, Bottlinger investigates the proper motions, etc. and finds that many stars belong to an extended Ursa Major group. Under these assumptions, he is thus enabled to calculate values of the parallaxes. In the table below are given the stars of this extended group whose parallaxes have been determined in the present series. 0″.005 has been added to the McCormick values to change them into absolute parallaxes. In the column giving the difference between the predicted and observed parallax, it will be seen at once that the star ξ Bootis is not a member of the

Star.	Theoretical π.	Observed π.	Difference Theor.-Obs.
ξ Eridani	+″.019	+″.015	+″.004
β Aurigæ	+.025	+.031	−.006
ζ Urs. Major (m)	+.046	+.037	+.009
g Urs. Major	+.042	+.034	+.008
78 Virginis	+.014	+.028	−.014
ξ Bootis	+.044	+.205	−.161
α Cor. Bor	+.041	+.061	−.020
β Serpentis	+.023	+.034	−.011
76 Cygni	+.013	+.010	+.003

Ursa Major group. Of the other eight stars, four have positive differences and four negative, while the average difference *Theoretical-Observed* is $-0''.003$.

Another method of testing the McCormick parallaxes is to see whether differences in the magnitude of the parallax star might not cause a systematic difference in the size of the parallax. This information can be obtained by comparing the parallaxes of two stars forming a physical system when these stars appear on the same series of plates. Among the McCormick parallaxes there are 27 stars which apparently form physical systems and for which the parallaxes were separately determined. Some of these pairs are separated by a small angular distance like Krueger 60, some more widely separated like the components of 61 Cygni. Some pairs have large differences of brightness like η Cassiopeiae, where the magnitudes are 3.6 and 7.6, while some are of nearly the same magnitude as in 16 Cygni which differ only one-tenth of a magnitude. The stars forming a physical system should have the same parallax. If the difference between the observed parallaxes of two members of a pair is taken in the sense *Brighter-Fainter*, then any difference in the parallax depending on magnitude should make itself manifest. In 14 of the 27 regions the brighter star has the larger parallax, in 12 the brighter star has the smaller parallax, while in one region the parallaxes are identical. The average of the 27 taken in the sense *Bright-Faint* is $+0''.0002$. 13 of the 27 have differences less than the average probable error $0''.009$, while in 20 of the 27 the differences are less than twice the probable error. The largest differences come from two regions where it was difficult to secure a satisfactory series of plates due to the low declination of $-20°$.

Still another very satisfactory criterion for testing the systematic errors of the McCormick parallaxes is the comparison of the values of the proper motions from the photographs with those determined from catalogues. 216 stars of the present series have had their proper motions determined by Boss. The average difference between Boss and the photographic result is slightly less than $0''.02$. The average deviations in the proper motions in the sense *McCormick-Boss* is $+0''.001$. Even this small difference can be accounted for since more parallaxes have been

measured between 18^h and 6^h of right ascension than between 6^h and 18^h. The solar apex has a right ascension of 18^h, and in consequence the comparison stars have a slight parallactic drift, which is shown by the proper motions.

Mean Parallaxes related to Proper Motions and Magnitudes.

The present series of parallaxes are sufficiently numerous to permit a test to be made of the connection between parallaxes on the one hand and brightness and proper motions on the other. It is quite natural to expect that the nearest stars should be those of the greatest brightness or those of the largest proper motions.

Kapteyn's empirical formula from *Publications of the Groningen Laboratory, No. 8* is:

$$\bar{\pi} = a\,\mu_1{}^b \epsilon^{m_1}$$

where $\mu_1 = 100\,\mu$ = the total angular motion of the star per century.

$m_1 = m - 5.0$, if m is the visual magnitude; and a, b, and ϵ are constants to be derived.

Substituting the values of μ_1 and m_1, then the equation reduces to:

$$\bar{\pi} = a\,(100\,\mu)^b\,\epsilon^{m-5.0}$$

or taking logarithms,

$$\log\,\bar{\pi} = b \log \mu + m \log \epsilon + \log A,$$

where $\log A = \log a + 2b - 5 \log \epsilon$.

It is not expected that this method will furnish the individual parallaxes of the stars, but rather that it will give an idea of the mean or average value of the parallax.

In *The Derivation of the Change of Color with Distance and Apparent Magnitude*, Groningen, 1915, van Rhijn makes an excellent discussion of the subject, and publishes tables of mean parallaxes. Since the B stars are on the average more distant than the A-type stars, and these in turn are more distant than the later types, F, G, K, and M, the stars were grouped by van Rhijn into three classes for discussion.

In making up the observing program for the McCormick Observatory preference was at first given to the later type stars. It will be interesting, therefore, to see whether the McCormick results show a relation between the parallaxes and the proper motions and magnitudes. In investigating the material, the two stars forming a physical system were treated as a single star having the combined magnitude of the pair. At the time that the computation was carried out the parallaxes of 166 separate systems of the F, G, K, and M types had been finished. The results appear in the following table:

MEAN PARALLAXES COMPUTED FROM MCCORMICK RELATIVE PARALLAXES.

Limits μ.	Limits m.	No.	$\bar{\pi}$ *Obs.*	$\bar{\pi}$ *Comp.*	π O—C.
$\leqq$ 0".100	0.00 – 3.50	27	".009	".011	−".002
$\leqq$ 0.100	3.51 – 5.00	22	.017	.010	+.007
".101 – ".250	0.00 – 3.50	11	.022	.034	−.012
.101 – .250	3.51 – 5.50	23	.038	.029	+.009
$\leqq$ .250	5.51 – 7.50	7	.009	.016	−.007
.250 – .600	0.00 – 3.50	5	.055	.067	−.012
.250 – .600	3.51 – 5.50	18	.053	.051	+.002
.250 – .600	5.51 – 7.50	4	.042	.050	−.008
.601 – .999	0.00 – 3.50	1	.108	.100	+.008
.601 – .999	3.51 – 5.50	8	.112	.093	+.019
.601 – .999	5.51 – 7.50	6	.056	.061	−.005
1.000 – 2.000	0.00 – 3.50	2	.170	.161	+.009
1.000 – 2.000	3.51 – 5.50	7	.172	.135	+.037
1.000 – 2.000	5.51 – 7.50	4	.080	.097	−.017
$\leqq$ .250	> 7.50	3	.017	.022	−.005
.251 – .999	> 7.50	8	.062	.045	+.017
1.000 – 2.000	> 7.50	3	.077	.082	−.005
> 2.000	All magns.	7	.242	.257	−.015

$\bar{\pi}$ *Obs.* denotes the mean of the values of the parallaxes of all the stars in the group, $\bar{\pi}$ *Comp.* the value computed from the formula. A probable error 0".009 results, which is equivalent to the probable error of the observed parallaxes. Within the different groups of stars, the ranges in the sizes of the parallaxes are quite large. In view of this range it is quite surprising that only one of the eighteen residuals shows a large value. One

should be very cautious, however, in basing any conclusions on the *average* where the individuals are few in number, since one discordant object may very greatly affect the average when the numbers are small.

The group of stars of total annual proper motion greater than 2″.0 consists of seven stars as in the following table, the stars being arranged in order of increasing proper motion:

STARS OF LARGE PROPER MOTION.

Star.	Magn.	μ.	Parallax.
Lalaned 27173	5.7	2″.05	+0″.189
Piazzi $2^h.123$	5.9	2.34	.137
$o^2$40 Eridani	4.5	4.08	.204
Lalande 21258	8.9	4.47	.177
61 Cygni	5.2	5.22	.307
Groombridge 1830	6.5	7.04	.106
Barnard's Star	9.7	10.3	+0.539

On the assumption that such a great range in values can hardly represent average conditions a second solution was made by least squares, omitting this group of seven stars. Very little change, however, resulted in the constants a, b, and ϵ.

The measured parallaxes available for Kapteyn's discussion were those in *Groningen* No. 24. As has already been stated, these older parallaxes are on the whole, too large and they are also subject to large systematic errors. It is quite natural, therefore, to expect that Kapteyn's mean parallaxes as shown particularly by his constant, a, should be too large. In 1915, there were available to van Rhijn additional measured parallaxes as follows: Chase, Smith and Elkin from the Yale heliometer; Flint, second series, from the meridian circle; Slocum and Mitchell by photography from the Yerkes refractor; and Abetti from the meridian circle. Van Rhijn had for his computation 247 parallaxes of the later type stars. Using the proper motions from the *Preliminary General Catalogue* of Boss, the radial velocities from *Lick Observatory Bulletin* 229, and assumimg the velocity of the sun to be 19.5 km. per sec., van Rhijn had additional infor-

mation from the parallactic motions of no less than 620 stars. The values of the constants a, b, and ϵ follow:

CONSTANTS FOR MEAN PARALLAXES OF F, G, K AND M STARS.

Authority.	a.	b.	ϵ.
Kapteyn (Groningen No. 8)	0.0049	0.65	0.905
Van Rhijn, 247 Measured Parallaxes	.0029	0.753	0.889
Van Rhijn, 247 Parallaxes supplemented by 620 Parallactic Motions	.0038	0.695	0.889
Van Rhijn, Table computed by	.0038	0.695	0.895
166 McCormick Relative Parallaxes	0.0031	0.744	0.881

For B and A type stars, van Rhijn computes tables from the constants:

	a.	b.	ϵ.
B-stars	0″.0031	0.904	0.895
A-stars	0.0028	0.80	0.895

The same value of the constant $\epsilon = 0.895$ was used by van Rhijn to compute all three tables for B, for A, and for the later type of stars, as given on pages 82, 83, and 84 of his publication.

Using parallaxes published in *Groningen* No. 24, Hertzsprung (*Astronomische Nachrichten*, 4975) derives the constants $a = 0''.0018$, $b = 0.75$, and $\epsilon = 0.89$.

The constants derived from the 166 McCormick relative parallaxes differ very little from those obtained by van Rhiin from 247 measured parallaxes. The addition of the parallactic motions of 620 stars which are mainly of small proper motion had the effect of changing the value of the constant b depending on proper motion, without changing ϵ which depends on magnitude. A change in the value of a came as a necessary consequence.

Attention should be called to the fact that the McCormick parallaxes in the above computation are *relative* and not *absolute* parallaxes.

Since the time when the constants were derived from the McCormick parallaxes many extra stars have been computed and additional parallaxes are available. Instead of making a new solution, it has seemed preferable to use van Rhijn's tables in

order to see how closely they represent the McCormick relative parallaxes. As before, the two stars of a physical system were treated as a single object. It should be emphasized that the mean parallaxes from the tables can provide only average results, and consequently large differences between the observed and tabular values should be expected. 196 stars of later type have had their parallaxes determined in the present series. The differences between observed and tabular parallaxes or *McCormick-Van Rhijn* were formed for each of the 196 stars. In the following table is given the number of stars within the limits as given by the quantities at the heads of the columns.

COMPARISONS WITH MEAN PARALLAXES FROM VAN RHIJN TABLES.
Differences *McCormick-van Rhijn*.

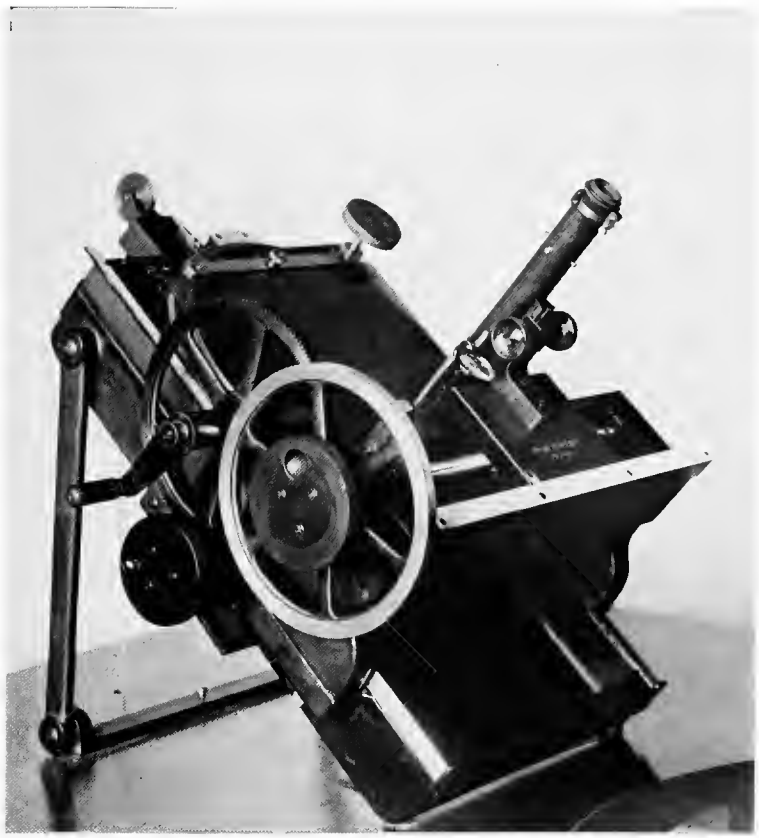
″.000.	″.000 to −″.009.	″.000 to +″.009	−″.010 to −″.019.	+″.010 to +″.019.	−″.020 to −″.029.	+″.020 to +″.029.	−″.030 to −″.039.	+″.030 to +″.039.	−″.040 to −″.049.	+″.040 to +″.049.
6	32	26	28	20	24	10	7	7	8	7
−″.050 to −″.059.	+″.050 to +″.059.	−″.060 to −″.069.	+″.060 to +″.069.	−″.070 to −″.079.	+″.070 to +″.079.	−″.080 to −″.089.	+″.080 to +″.089.		> −″.100.	> +″.100.
2	4	1	1	2	1	0	2		1	7

In the top half of the table where the differences are less than 0″.05, it will be seen that 99 stars furnish positive differences McCormick-van Rhijn, only 70 give negative values, while for 6 stars the observed and tabular values are identical. For these 175 stars in the top half of the table, the total negative differences exceed those positive by 0″.393. If, therefore, all differences were neglected where the discrepancies were greater than 0″.05 we would be forced to the conclusion that the van Rhijn mean parallaxes are larger than the McCormick relative parallaxes by the average amount of 0″.002.

Of the 21 stars mainly of large proper motion in the lower half of the table the observed parallaxes are larger than the tabular in 15 cases and smaller in only six. This is a condition of affairs that might be expected, for stars nearer to us than the average, and thus

with larger parallaxes, may be observed, while those farther away than the average may fail of detection. If to the 175 stars in the top half of the table there are added 13 stars from the lower half so that the comparison shall therefore include all stars where the differences are less than 0".10, then the accumulated differences McCormick-van Rhijn for 188 stars is −0".143, or the McCormick parallaxes are smaller than the tabular values by 0".001. The addition of any one star from the list of seven in the table of exceptional stars below which have positive differences McCormick-van Rhijn greater than 0".1 would be sufficient to practically wipe out the accumulated difference of −0".143. Since Groombridge 1830 furnishes a large negative difference, then by taking it with two extra stars with positive differences there will result an almost perfect agreement on the average between McCormick parallaxes and van Rhijn tabular values. Only five stars out of 196 are thus left out of the comparison, each with a large positive difference. If, however, these five are also included, then the total difference for all 196 stars is 0".932, or an average of 0".005 that the observed parallaxes are greater than the tabular values. This should not be interpreted to mean that the McCormick parallaxes have a systematic error amounting to + 0".005. This positive value results from the addition of a very few stars which are in every sense *exceptional* stars and not *average* stars. One of these exceptional stars is Barnard's Proper Motion star which has the largest proper motion of any star known, and it has the added distinction of being one of the faintest stars known, having a luminosity only 0.0004 that of the sun.

Stars are not all formed in the same mold, and on account of their great differences in mass, in brightness, and in motion one should not expect that their distances or parallaxes could be adequately represented by any mathematical formula. Van Rhijn's constants probably represent mean parallaxes as well as any formula can. Attention should again be called to the fact that van Rhijn's constants represent the McCormick observed parallaxes remarkably well. The McCormick parallaxes are relative to the set of comparison stars chosen and are not absolute in amount. In order to obtain absolute parallaxes



Gaertner Machine for Measuring Photographs.

0″.005 should be added to the values from the tables of van Rhijn.

In the following table are listed 15 exceptional stars where the differences between the McCormick and tabular parallaxes are greater than 0″.06. The stars are arranged in order of increasing difference McCormick-van Rhijn. All of the eight stars where the differences are greater than 0″.10 have had their parallaxes well determined by several authorities.

FIFTEEN EXCEPTIONAL STARS.

Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	McCormick π.	Mean π.	$M - vR$.
δ Leporis	5^h47^m	$-20°53'$	3.90K	+″.019	+″.083	−″.064
70 Ophiuchi (m)	18 0	+ 2 30	3.94K	+.178	+.110	+.068
γ Leonis (m)	10 14	+20 20	2.33K	−.012	+.060	−.072
χ Orionis	5 48	+20 15	4.62F8	+.105	+.032	+.073
θ Urs. Majoris	9 26	+52 7	3.26F8	+.032	+.110	−.078
γ Leporis (m)	5 40	−22 28	3.80F8	+.144	+.064	+.080
π^3 Orionis	4 44	+ 6 47	3.31F8	+.151	+.063	+.088
Lal. 25372	13 40	+15 26	8.7 K	+.224	+.104	+.120
α Canis Min	7 34	+ 5 29	0.48Fs	+.309	+.178	+.131
τ Ceti	1 39	−16 27	3.65K	+.312	+.171	+.141
Groomb. 1830	11 47	+38 26	6.46Gp	+.106	+.274	−.168
ξ Bootis	14 46	+19 31	4.64Ksp	+.200	+.026	+.174
ϵ Eridani	3 28	− 9 48	3.81K	+.302	+.105	+.197
Krueger 60 (m)	22 24	+57 11	9.3 Mb	+.266	+.060	+.206
Barnard's Star	17 54	+ 4 25	9.7 Mb	+.539	+.265	+.274

COMPARISONS WITH SPECTROSCOPIC PARALLAXES.

On account of the much greater number of stars involved, a better method of deriving the systematic errors of the present series of parallaxes will probably come from the detailed comparison with the spectroscopic values of Mt. Wilson, there being no less than 194 stars in common. Through the kindness of Dr. Walter S. Adams, the results in Table 5 were communicated in advance of publication. Nearly all of the McCormick stars of later types have had their parallaxes determined spectro-

scopically. As pointed out on p. 38, Adams and Joy have compared the relative intensities of certain lines in the spectra of the stars, and by means of curves derived from parallaxes trigonometrically determined the absolute magnitude of each star is found. The spectroscopic method is primarily a method of determining absolute magnitudes. If the visual magnitude is known, the parallax of the star can be found by a simple formula. To obtain parallaxes on a uniform system all steps in the process must be known with great accuracy: the estimations of the relative intensities of the spectral lines must be carefully made, the curves of the various spectral types must be thoroughly investigated, and the visual magnitudes, those of the revised Harvard Photometry, must be on a uniform system.

Since the publication in 1917 of *The Luminosities and Parallaxes of Five Hundred Stars*, Adams and Joy have made two revisions of their results. The first revision was based on *all* parallaxes known to 1920, many of the photographic results having been communicated in advance of publication. A second revision of the standards of reduction has been based on 657 stars whose parallaxes have been determined photographically at Allegheny, Yerkes, Mt. Wilson, and McCormick observatories, about 115 of these stars being common to two or more observers, (*Publ. Astron. Socy. Pacific*, **32**, 195, 1920). The spectroscopic parallaxes for the McCormick stars given in Table 5 are the values from this second revision. According to the investigations of Adams, Joy, and Strömberg (*loc. cit.*), the average difference between the spectroscopic and the McCormick parallaxes for 194 stars is $0''.0006$, the spectroscopic being the larger in value, while the mean deviation is $0''.0193$.

Since the spectroscopic parallaxes in Table 5 are founded on the best of the modern photographic parallaxes, the close agreement between the McCormick and the spectroscopic parallaxes shows that the McCormick parallaxes must be nearly on the same system as the average of the photographic values. In other words, there is little indication of any systematic errors in the McCormick parallaxes. What is here said regarding the McCormick parallaxes is equally true of the results determined by photography at Allegheny, Mt. Wilson, and Yerkes Observa-

tories. There are indeed errors in the parallax values for the individual stars furnished by each of the four observatories, at times unfortunately, much larger than one would expect from the small size of the probable errors.

If the difference from the spectroscopic results should be treated as a systematic error, then the McCormick parallaxes should have a systematic correction amounting to + 0".0006. In the *Astronomical Journal*, **33**, 17, 1920, from less complete data, Boss finds the systematic correction to the McCormick parallaxes of + 0".0014. An unpublished investigation by van Maanen, referred to in *Mount Wilson Contributions*, **182**, 9, 1920, shows the correction to the McCormick parallaxes to be between − 0".001 and − 0".002. If one should take the mean of these three independent determinations, the conclusion is reached that the systematic errors of the McCormick parallaxes is less than 0".001.

The writer believes that the photographic parallaxes of Allegheny, Mt. Wilson, Yerkes and McCormick are without *systematic* errors, the differences between the parallaxes from these four observatories being entirely due to differences in the individual results of a very small number of stars.

When one recalls the various steps in the process of determining parallaxes spectroscopically one cannot but wonder at the marvelously good agreement of the spectroscopic parallaxes. One of the steps involved is a knowledge of the visual magnitudes which were derived from the *Revised Harvard Photometry*. The excellent agreement of the spectroscopic parallaxes speaks well for the uniformity of the visual magnitudes derived at Harvard.

Masses.

When the orbit of a binary system is known, the sum of the masses of the two components compared with the mass of the sun is readily determined by a well-known and simple formula. In selecting the stars for the observing program at the McCormick Observatory, there was no special plan on hand to put double stars under special observation. Where the elements of the stellar orbit are known with a degree of precision sufficient to give a good idea of the size of the semi-major axis and the

period, the masses were found, and the results are collected in Table 4 below.

Mass-ratios.

In a binary system measured for parallax, the proper motion determined by photography may differ from the value obtained from star catalogues. As already pointed out (p. 36), by photography the proper motions are determined with respect to a particular group of comparison stars instead of being referred to the system of stars as a whole, as in meridian circle work. To obtain photographic proper motions on the same system as those from meridian circles it would be necessary to know the proper motions of the comparison stars which on the average are of the 10th magnitude. It is manifestly impossible at the present state of astronomical investigation to know these individual proper motions. However, it might be possible to make allowance for the parallactic drift of these tenth-magnitude comparison stars with respect to the system of the stars, for, manifestly, these drifts per year will amount to about four times* the size of the annual parallax of stars of tenth magnitude. Of course it is still uncertain what is the size of the average parallax of stars of tenth magnitude.

In a binary system like η Cassiopeiæ, the proper motions of both stars of the system have been determined by photography. Each of the stars in the orbit moves about the common center of gravity. The motion for each star with respect to this center of gravity is inversely proportional to the mass. Consequently, if the meridian circle observations could furnish the proper motion of the center of gravity with a precision comparable with that attained by photography it would be a simple matter to obtain the ratio of the masses of the two stars. In the average meridian circle a double like η Cassiopeiæ would appear as a single star, and the position furnished would be that of the center of brightness, which does not necessarily coincide with the center of gravity. Fuller information on this subject can be found by reference to the *Preliminary General Catalogue* of Boss. The proper motion of a double star given by Boss is therefore not

* Publications of the Astronomical Laboratory at Groningen, **29**, 34.

necessarily the proper motion of the center of gravity. To eliminate the effect due to orbital motion, the meridian circle observations should stretch throughout a whole period of the double. For very few stars is the proper motion of the center of gravity known with sufficient precision to permit the determination of mass-ratios even with a fair degree of accuracy.

When the photographs furnish the proper motions of both components of a binary, the determination of the ratios for the masses is a very simple process. Where only the brighter star has been measured the method shown by van Biesbroeck, *Astronomical Journal*, **29**, 173, 1916, must be followed.

TABLE 4.
MASSES AND MASS-RATIO.

Star.	R. A. 1900.	Decl. 1900.	Magns.	Mass of System, ⊙ = 1.	Ratio of Masses, *B/A*.
Piazzi 0^h130	0^h32^m	−25°19′	6.6, 6.7	0.68	
η Cassiopeiæ	0 43	+57 17	3.6, 7.6		0.34
o^2 Eridani, *BC*	4 10	− 7 48	9.4, 10.8	3.72	*B* = *C*
α Geminorum	7 28	+32 6	2.0, 2.8		*A* > *B*
α Canis Min.	7 34	+ 5 29	0.5, 13.5	1.41	
9 Puppis	7 47	−13 38	5.8, 6.4	11.0	0.32
ϵ Hydræ	8 41	+ 6 47	3.9, 4.4	71.3	*A* = *B*
Lalande 25224	13 34	+11 15	6.5, 6.5	0.88	
ξ Scorpii, *AB*	15 59	−11 5	4.8, 5.1	4.36	*A* < *B*
λ Ophiuchi	16 25	+ 2 12	4.0, 6.1	19.7	
μ Herculis, *BC*	17 42	+27 47	10.0, 10.5	4.1	
70 Ophiuchi	18 0	+ 2 31	4.1, 6.0	1.67	0.79
99 Herculis	18 3	+30 33	5.2, 10.5	4.1	
ζ Sagitarii	18 56	−30 1	3.4, 3.6	33.1	
Secchi 2	19 8	+38 37	8.7, 8.7	0.38	
β Delphini	20 32	+14 14	4.0, 5.0	3.92	
ϵ Equulei, *AB*	20 54	+ 3 55	5.8, 6.3	5.8	
δ Equulei	21 9	+ 9 36	5.3, 5.4	6.2	
τ Cygni	21 10	+37 37	3.8, 8.0	6.15	
κ Pegasi	21 40	+25 11	5.0, 5.1	20.4	
Krueger 60, *AB*	22 24	+57 11	9.3, 10.8	0.40	6:5*

*See *Astronomical Journal*, 767.

In the preceding table are collected the masses and mass-ratios determined from the McCormick photographs. In calculating the mass-ratios allowance was made for the parallactic drift of the comparison stars.

Summary.

1. The parallaxes of 260 stars have been found with an average probable error of 0″.009. The average probable error of a single plate of good quality on which are impressed two images is 0.0013 millimeters, or 0″.027. On the average 4.5 comparison stars were used.

2. Although there may be departures from the truth for individual stars by amounts greater than is indicated by the probable error, comparisons with other recent photographic parallaxes for one-half of the stars measured show an excellent agreement, the average deviation between McCormick and other parallaxes photographically determined being 0″.015. On the average the McCormick parallaxes are larger than those of the other photographic authorities by an amount which is less than 0″.001.

3. 194 of the McCormick stars have had their parallaxes determined by the spectroscope at Mt. Wilson. The average deviation between McCormick and the spectroscopic is 0″.019 so that the McCormick parallaxes agree with the spectroscopic values almost as well as with the best photographic values. On the whole the McCormick results are smaller than the Mt. Wilson spectroscopic parallaxes by 0″.0006.

4. Comparisons of the McCormick parallaxes with the theoretical parallaxes determined for an extended Ursa Major group show the observed and theoretical parallaxes to be in good agreement. The large observed parallax of ξ Bootis (0″.200) shows that it is not a member of the Ursa Major group.

5. Constants derived from the McCormick parallaxes for Kapteyn's empirical formula are in good agreement with those derived by van Rhijn.

6. Comparisons with van Rhijn's tables of mean parallaxes show that these tables represent the McCormick parallaxes as well as could be expected from any empirical formula giving mean parallaxes.

7. Large departures from mean parallaxes are shown by fifteen exceptional stars.

8. Comparisons with the best visual work by heliometer and meridian circle show that on the average the visual parallaxes are larger than the McCormick values by 0″.015.

9. The parallaxes determined visually are subject to large systematic errors, and they have a much smaller degree of precision than the photographic parallaxes.

10. Barnard's star of larger proper motion and the companion B of Krueger 60 are intrinsically among the faintest stars yet known to astronomy, each possessing a luminosity about 0.0004 times that of the Sun.

11. In the present work, the masses of 21 stellar systems have been found. The companion of Krueger 60 has the smallest mass of any star yet known with certainty, having a mass about one-seventh that of the sun.

12. The ratios of the masses of the components of 8 stellar systems have been found.

13. Comparisons of the proper motions from the McCormick photographs with those from the *Preliminary General Catalogue* of Boss show a very close agreement.

14. The McCormick parallaxes have been treated by various methods with the conclusion that any systematic errors must be less than 0″.001.

15. The first parallax was measured in 1838. In 1880 there were 20 parallaxes, in 1900 there were 60. In 1910 Kapteyn listed the parallaxes of 360 stars, though according to Campbell most of these distances were known with little accuracy. In 1910, we had "approximate knowledge of the distances of 100 stars." In May 1917, the measured parallaxes of 625 stars were compiled by Walkey, and in September of the same year a similar compilation was made by Heath of 734 stars.

16. Parallaxes are now being determined by photography with telescopes of great focal length at the rate of at least 200 per year. With the information already available from the determination of proper motion and the measures of velocities in the line of sight, modern astronomers will soon be in a position to solve anew such interesting questions as the construction of the universe, the motions of the stars, star-streaming, etc.

17. In Table 5 are gathered the summary of measures of parallax and proper motion. 0".005 has been subtracted from the values of the spectroscopic parallax of Mt. Wilson. The proper motion measured on the plates was the component in right ascension, or $\mu\alpha$ Cos δ. The corresponding value is taken from Boss or Porter, those from Porter being marked by an asterisk (*). In the column "Measurer" is given the initials of the person responsible for the measurement of the plates. It has always been the policy of the McCormick Observatory to have each series of plates measured when possible by one person only. On account of changes in the personnel of the observatory staff the measurement of a series of plates started by one person at times has been completed by another. In such cases the initial of the person is given who measured the majority of the plates, as follows:

M = S. A. Mitchell.
Ol = C. P. Oliver.
A = H. L. Alden.
G = P. H. Graham.
L = R. C. Lamb.
B = G. B. Briggs.
D = Marguerite D. Darkow.
H = M. Alberta Hawes.
F = Jennie V. France.

TABLE 5.

SUMMARY.

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
1	β Cassiop.....	$0^h\ 3^m$	$+58°35'$	2.42 F_5	$0''.54$	$+0''.058 \pm 0''.011$	$+0''.064$	$+0''.524$	$+0''.529$	M
2	Piazzi $0^h.130$.....	0 32	-25 19	5.71 K_0	1.39	$+ .086 \pm .010$	.061	+1.394	+1.384	A
3	α Cassiop.....	0 34	+55 59	2. 2 K_0 2. 8	0.060	$+ .025 \pm .005$	.015	+0.041	+0.051	M
4	54 Piscium.....	0 34	+20 42	6.08 K_0	0.61	$+ .101 \pm .012$	.100	-0.477	-0.463	D
5	Lalande 1198.....	0 39	+ 1 15	8.14 K_0	0.591	$+ .039 \pm .008$	.045	-0.058	-0.063*	Ol
6	η Cassiop. A.....	0 43	+57 17	3.64 F_8	1.242	$+ .180 \pm .008$	.161	+1.171	+1.127	M
7	η Cassiop. B.....	0 43	+57 17	7.6 K_0	1.242	$+ .178 \pm .009$	.161	+0.999	+1.127	M
8	Lal. 1799.....	0 57	+ 4 31	8.4 K_2	0.438	$+ .022 \pm .007$	.058	+0.268	+0.353*	H
9	ϵ Piscium	0 57	+ 7 21	4.45 K_0	0.085	$+ .022 \pm .008$	.009	-0.066	-0.080	A
10	β Androm.....	1 4	+35 5	2.37 Ma	0.216	$+ .058 \pm .008$	.037	+0.248	+0.181	Ol
11	θ Cassiop.....	1 5	+54 37	4.52 A_5	0.230	$+ .047 \pm .013$		+0.178	+0.229	A
12	ω Androm.....	1 22	+44 53	4.96 F_5	0.356	$+ .023 \pm .010$	.028	+0.372	+0.344	A
13	η Piscium.....	1 26	+14 49	3.72 G_5	0.031	$+ .046 \pm .010$	.010	-0.019	+0.029	Ol
14	ν Androm	1 31	+40 54	4.18 G_0	0.418	$+ .052 \pm .008$	.074	-0.190	-0.179	G
15	41 H Androm.....	1 35	+42 6	5.10 F_8	0.82	$+ .092 \pm .013$	.082	+0.854	+0.807	A
16	τ Ceti.....	1 39	-16 27	3.65 K_0	1.922	$+ .312 \pm .016$	.311	-1.711	-1.717	M
17	β Trianguli.....	2 3	+34 30	3.08 A_5	0.159	$+ .016 \pm .008$		+0.156	+0.152	B
18	Lalande 4141.....	2 9	+23 49	6.86 G_5	0.494	$+ .034 \pm .007$	.031	+0.450	+0.452*	H
19	δ Trianguli.....	2 10	+33 46	5.07 G_0	1.15	$+ .127 \pm .010$	.082	+1.183	+1.153	A
20	Lalande 4268.....	2 13	+ 1 17	5.82 F_8	0.527	$+ .019 \pm .005$	.031	+0.407	+0.367	Ol

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
21	o Ceti	2^h14^m	$-3°25'$	2-9 Md	$0''.237$	$+0''.061 \pm 0''.007$		$-0''.001$	$-0''.001$	M
22	Piazzi $2^h.123$	2 30	+ 6 24	5.92 K_0	2.34	+ .137± .005	$+0''.133$	+1.791	+1.802	Ol
23	γ Ceti	2 38	+ 2 49	3.58 A_2	0.210	+ .037± .008	.033	−0.059	−0.147	M
24	α Ceti	2 57	+ 3 41	2.82 Ma	0.078	+ .017± .010	.021	+0.018	−0.013	A
25	γ Persei	2 57	+53 6	3.08 Gp	0.010	+ .002± .012	.018	−0.039	+0.004	A
26	ρ Persei	2 58	+38 27	3.4 4.2 Mc	0.173	+ .029± .012	.007	+0.105	+0.135	L
27	α Persei	3 17	+49 30	1.90 F_5	0.039	+ .013± .010	.018	+0.032	+0.027	A
28	Lalande 6320	3 20	− 5 42	8.1 K_0	0.816	+ .060± .010	.064	−0.266	−0.266*	A
29	ϵ Eridani	3 28	− 9 48	3.81 K_0	0.972	+ .302± .007	.276	−0.986	−0.971	M
30	10 Tauri	3 31	+ 0 5	4.40 G_5	0.536	+ .043± .006	.064	−0.260	−0.234	M
31	Σ 422	3 31	+ 0 15	6.12 G_0	0.151	+ .007± .007	.047	−0.077	−0.021	M
32	W. B. $3^h.617$	3 35	− 3 32	6.74 F_8	0.745	+ .021± .008	.017	+0.682	+0.713*	A
33	ν Persei	3 38	+42 15	3.93 F_5	0.009	+ .028± .012	.016	+0.029	+0.009	Ol
34	δ Eridani	3 38	−10 6	3.72 K_0	0.749	+ .134± .011	.082	−0.083	−0.093	M
35	Lalande 6888	3 40	+41 9	8.2 G_5	1.38	+ .022± .009	.014	+0.629	+0.599	M
36	Lalande 6889	3 40	+41 9	8.8 G_5	1.38	+ .028± .009	.033	+0.631	+0.599	M
37	τ^6 Eridani	3 42	−23 32	4.33 F_8	0.548	+ .068± .010	.043	−0.162	−0.163	M
38	32 Eridani Bt.	3 49	− 3 15	4.95 Gp	0.035	+ .008± .010	.006	+0.031	+0.034	F
39	32 Eridani Ft.	3 49	− 3 15	6.33 A	0.035	− .009± .009		+0.032		F
40	γ Eridani	3 53	−13 47	3.19 K_5	0.130	+ .014± .012	.024	+0.045	+0.067	A

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. −0″.005.	Obs.	Boss.	
41	43 Tauri	4h 3m	+19°20′	5.67 G_5	0″.114	+0″.019±0″.012	+0″.008	+0″.076	+0″.075	A
42	o^2 40 Erid. A	4 10	− 7 48	4.48 G_5	4.085	+ .194± .009	.211	−2.224	−2.220	M
43	o^2 40 Erid. BC	4 10	− 7 48	9.7 A	4.085	+ .214± .008		−1.767		M
44	ξ Eridani	4 18	− 3 58	5.23 A_2	0.072	+ .010± .009		−0.083	−0.050	A
45	α Tauri	4 30	+16 19	1.06 K_5	0.201	+ .035± .008	.093	+0.072	+0.069	M
46	Boss 1128	4 42	+63 20	5.81 Ma	0.113	− .003± .011	.005	+0.027	+0.056	H
47	π^3 Orionis	4 44	+ 6 47	3.31 F	0.471	+ .151± .009	.113	+0.497	+0.471	M
48	A. G. Leip. 1819	4 44	+ 6 48	7.05 A_2	—	− .002± .015		−0.026		M
49	W. B. 4h.1189	4 56	− 5 52	6.50 K_0	1.247	+ .124± .007	.113	+0.562	+0.550*	Ol
50	ε Leporis	5 1	−22 30	3.29 K_5	0.072	+ .017± .011	.025	+0.026	+0.026	B
51	λ Aurigæ	5 12	+40 0	4.85 G_0	0.846	+ .064± .009	.074	+0.534	+0.529	F
52	β Leporis	5 24	−20 50	2.96 G_0	0.094	− .001± .005	.013	+0.007	+0.006	Ol
53	W. B. 5h.592	5 26	− 3 41	8.8 K_2	2.222	+ .164± .009	.177	+0.811	+0.744*	D
54	α Leporis	5 28	−17 53	2.69 F_0	0.003	+ .009± .008	.050	+0.023	+0.001	M
55	Groomb. 990	5 30	+51 22	7.9 K_0	0.563	+ .024± .007	.039	−0.567	−0.552*	F
56	γ Leporis Bt.	5 40	−22 28	3.80 F_8	0.468	+ .148± .009	.095	−0.277	−0.296	M
57	γ Leporis Ft.	5 40	−22 28	6.41 G_5	0.461	+ .140± .007	.140	−0.274	−0.278	M
58	δ Leporis	5 47	−20 53	3.90 K_0	0.696	+ .019± .010	.028	+0.239	+0.241	H
59	χ Orionis	5 48	+20 15	4.62 F_8	0.208	+ .105± .006	.100	−0.145	−0.186	A
60	δ Aurigæ	5 51	+54 17	3.88 K_3	0.153	− .004± .006	.018	+0.078	+0.086	A

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. —0″.005.	Obs.	Boss.	
61	η Leporis	5^h51^m	−14°11′	3.77 F_0	0″.138	+ ″.031± ″.010	+0″.053	−0″.012	−0″.041	Ol
62	β Aurigæ	5 52	+44 56	2.07 Ap	0.047	+ .026± .009		−0.076	−0.047	A
63	η Geminorum	6 8	+22 32	3.2 4.2 Ma	0.065	− .001± .010	.009	−0.045	−0.062	Ol
64	2 Lyncis	6 10	+59 2	4.42 A_0	0.022	+ .021± .011		+0.005	−0.005	Ol
65	Boss 1599	6 15	− 2 54	5.18 Ma	0.009	− .009± .010	.004	−0.012	−0.009	Ol
66	μ Geminorum	6 16	+22 33	3.19 Ma	0.128	+ .011± .007	.028	+0.043	+0.061	Ol
67	β Canis Maj.	6 18	−17 54	1.99 B_1	0.002	+ .007± .010		+0.024	−0.006	M
68	47 Aurigæ	6 22	+46 45	6.01 K_0	0.007	+ .012± .010	.003	+0.006	+0.005	D
69	ϵ Geminorum	6 37	+25 13	3.18 G_5	0.020	.000± .009	.007	+0.014	0.000	Ol
70	ξ Geminorum	6 39	+13 0	3.40 F_5	0.231	+ .037± .007	.047	−0.118	−0.114	Ol
71	97 Monocerotis	6 45	− 0 25	5.83 F_2	0.175	+ .026± .009	.043	+0.001	+0.008	A
72	Lalande 13427	6 54	+48 31	8.2 K_0	0.697	+ .007± .007	.039	+0.556	+0.540*	H
73	Boss 1846	7 5	+51 35	5.69 Ma	0.018	− .011± .012	.003	+0.019	+0.018	H
74	Lalande 14146	7 11	−12 53	7.72 G_5	0.513	+ .031± .010	.016	−0.488	−0.501*	A
75	δ Geminorum	7 14	+22 9	3.51 F_0	0.023	+ .060± .006	.028	−0.041	−0.016	Ol
76	ι Geminorum	7 19	+28 0	3.89 K_0	0.145	+ .008± .006	.016	−0.085	−0.082	A
77	ρ Geminorum	7 22	+31 59	4.18 F_0	0.236	+ .052± .007	.024	+0.173	+0.149	M
78	α^1 Geminorum	7 28	+32 6	2.85 A_0	0.204	+ .086± .007		−0.119	−0.172	A
79	α^2 Geminorum	7 28	+32 6	1.99 A_0	0.204	+ .067± .010		−0.182		A
80	α Canis Min.	7 34	+ 5 29	0.48 F_5	1.25	+ .309± .007	.353	−0.690	−0.666	M

TABLE 5.—*Continued.*

No.	Star.	R. A: 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boas.	
81	γ Monocerotis	7^h37^m	$-9°19'$	4.07 K_0	$0''.079$	$0''.000 \pm 0''.011$	$+0''.014$	$-0''.076$	$-0''.076$	A
82	κ Geminorum	7 38	+24 38	3.68 G_5	0.066	+ .014± .008	.023	−0.019	−0.022	L
83	9 Puppis	7 47	−13 38	5.34 G_0	0.344	+ .036± .008	.078	+0.035	−0.060	M
84	Lal. 15290	7 47	+30 54	8.2 G_0	1.962	+ .033± .007	.015	+0.701	+0.732*	M
85	ρ Puppis	8 3	−24 0	2.88 F_5	0.100	+ .026± .008	.024	−0.060	−0.089	Ol
86	Lal. 15950	8 5	+32 46	6.95 G_0	0.82	+ .040± .010	.053	−0.456	−0.454	A
87	β Cancri	8 11	+ 9 29	3.76 K_2	0.075	− .002± .010	.016	−0.079	−0.052	Ol
88	Lal. 16304	8 13	−12 17	6.04 G_5	1.03	+ .060± .007	.105	+0.285	+0.279	Ol
89	Lal. 17046	8 34	+11 53	7.9 G_5	0.531	+ .026± .009	.043	−0.113	−0.104*	A
90	δ Cancri	8 39	+18 31	4.17 K_0	0.240	+ .038± .009	.016	+0.009	−0.017	Ol
91	ι Cancri Bt.	8 40	+29 7	4.20 G_5	0.054	+ .026± .006	.003	−0.022	−0.020	M
92	ι Cancri Ft.	8 40	+29 7	6.61 A_5	0.054	+ .031± .006		−0.037		M
92	ϵ Hydræ	8 41	+ 6 47	3.48 F_8	0.196	+ .004± .010	.047	−0.177	−0.189	A
94	53 Cancri	8 46	+28 38	6.31 Ma	0.022	− .005± .012	.000	+0.002	−0.016	Ol
95	55 Cancri	8 46	+28 43	6.06 K_0	0.55	+ .076± .011	.078	−0.523	−0.481	Ol
96	ζ Hydræ	8 50	+ 6 19	3.30 K_0	0.103	.000± .010	.009	−0.105	−0.103	A
97	38 Lyncis	9 12	+37 13	3.82 A_2	0.136	+ .039± .010		+0.016	−0.026	D
98	θ Urs. Maj.	9 26	+52 7	2.36 F_8p	1.092	+ .032± .008	.082	−0.952	−0.945	M
99	λ Leonis	9 26	+23 24	4.48 K_5	0.056	+ .034± .008	.011	−0.009	−0.023	A
100	o Leonis	9 35	+10 21	3.76 F_5p	0.150	+ .029± .012		−0.113	−0.145	A

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
101	35 Leonis	10^h11^m	+24° 0′	5.91 G_0	0″.209	+0″.005±0″.008	+0″.021	−0″.181	−0″.208	M
102	ζ Leonis	10 11	+23 54	3.65 F_0	0.027	+ .005± .007	.012	+0.013	+0.022	M
103	γ^1 Leonis	10 14	+20 20	2.61 K_0	0.339	− .002± .009	.043	+0.376	+0.302	M
104	γ^2 Leonis	10 14	+20 20	3.80 K_0	0.353	− .021± .015	.011	+0.385	+0.302	M
105	40 Leonis	10 14	+19 58	4.97 F_5	0.329	+ .047± .009	.039	−0.218	−0.234	Ol
106	β Leo Minor	10 22	+37 13	4.41 K_0	0.164	+ .008± .009	.018	−0.128	−0.122	A
107	46 Leo Minor	10 47	+34 45	3.92 K_0	0.304	+ .047± .009	.028	+0.076	+0.091	M
108	Lal. 21258	11 0	+44 2	9.2 K_5	4.519	+ .177± .012	.177	−4.398	−4.334*	M
109	χ Leonis	11 0	+ 7 53	4.66 F	0.348	+ .007± .010	.011	−0.302	−0.345	Ol
110	Lal. 21565	11 13	− 4 31	7.34 K_0	0.806	+ .043± .012	.055	+0.818	+0.793	D
111	λ Draconis	11 25	+69 52	4.06 Ma	0.042	+ .013± .005	.010	−0.048	−0.034	Ol
112	93 Leonis	11 42	+20 46	4.54 F_8	0.155	+ .024± .009	.047	−0.123	−0.156	G
113	β Virginis	11 45	+ 2 20	3.80 F_8	0.793	+ .096± .008	.082	+0.751	+0.743	M
114	Groomb. 1830	11 47	+38 26	6.46 G_5	7.037	+ .106± .008	.074	+4.053	+4.004	M
115	γ Urs. Maj	11 48	+54 15	2.54 A_0	0.093	− .002± .007		+0.131	+0.093	A
116	Boss 3137	11 55	− 9 52	5.63 G_5	0.491	+ .087± .012		+0.054	+0.109	D
117	ϵ Corvi	12 5	−22 3	3.21 K	0.064	+ .021± .009	.024	−0.023	−0.063	F
118	β Canum Ven	12 29	+41 54	4.32 G_0	0.78	+ .102± .009	.102	−0.671	−0.701	H
119	θ Virginis	13 4	− 5 0	4.44 A	0.058	+ .006± .006		−0.029	−0.039	M
120	β Comæ	13 7	+28 23	4.32 G_0	1.184	+ .140± .013	.115	−0.798	+0.797	A

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boas.	
121	61 Virginis	13^h13^m	$-17°45'$	4.80 K	1.51	$+0''.130\pm0''.011$	$+0''.100$	$-1''.011$	$-1''.077$	L
122	γ Hydræ	13 13	−22 39	3.33 G_5	0.084	+ .007± .010	.017	+0.176	+0.067	Ol
123	ζ^1 Urs. Maj.	13 19	+55 26	2.40 Ap	0.129	+ .046± .010		+0.108	+0.126	M
124	ζ^2 Urs. Maj.	13 19	+55 26	3.96 A_2	0.137	+ .017± .009	.018	+0.103	+0.132	M
125	g Urs. Maj.	13 21	+55 30	4.02 A_5	0.124	+ .029± .009		+0.123	+0.122	M
126	70 Virginis	13 23	+14 19	5.16 G_5	0.634	+ .045± .008	.050	−0.250	−0.243	A
127	o Virginis	13 29	+ 4 10	4.93 Ap	$0''.052$	+ .023±0.010		+0.052	+0.042	A
128	Lal. 25224	13 34	+11 15	5.54 A	0.112	+ .024± .006	.006	−0.054	−0.111	L
129	Lal. 25372	13 40	+15 26	8.7 K	2.298	+ .224± .016	.204	+1.728	+1.780*	Ol
130	μ Virginis	14 37	− 5 13	3.95 F_5	0.339	+ .043± .010	.043	+0.125	+0.106	A
131	ξ Boötis	14 46	+19 31	4.64 G_5	0.168	+ .200± .012	.153	+0.150	+0.150	Ol
132	β 31	14 48	+19 8	8.0 K_0	0.185	+ .002± .010	.017	+0.007	−0.022*	Ol
133	Lal. 27173 Bt.	14 51	−20 57	5.76 Kp	2.039	+ .172± .010	.161	+0.994	+1.034	M
134	Lal. 27173 Ft.	14 51	−20 57	8.7 Ma	2.07	+ .206± .005	.204	+0.812	+0.949	M
135	β Boötis	14 58	+40 47	3.63 G_5	0.063	+ .037± .015	.008	−0.032	−0.046	A
136	μ Boötis A	15 20	+37 43	4.47 F	0.169	+ .049± .008	.030	−0.112	−0.149	D
137	μ Boötis BC	15 20	+37 43	6.66 K	0.169	+ .031± .009	.027	−0.146	−0.145	D
138	α Cor. Bor.	15 30	+27 3	2.31 A	0.157	+ .056± .010		+0.114	+0.120	Ol
139	α Serpentis	15 39	+ 6 44	2.75 K_0	0.139	+ .038± .008	.024	+0.129	+0.135	M
140	β Serpentis	15 41	+15 44	3.74 A_2	0.091	+ .029± .008		+0.045	+0.071	M

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. —0.″005.	Obs.	Boss.	
141	γ Serpentis	15^h51^m	+15°59′	3.86 F_8	1.″32	+0.″098±0.″008	+0.″110	+0.″278	+0.″302	A
142	ρ Cor. Bor.	15 57	+33 36	5.43 F	0.780	+ .018± .012	.039	−0.187	−0.213	H
143	ξ Scorp. AB	15 59	−11 5	4.7 F_8	0.071	+ .018± .010	.033	−0.018	−0.062	M
144	ξ Scorp. C	15 59	−11 5	7.2	0.080	+ .046± .012	.035	−0.064	−0.075	M
145	ν Scorp. AB	16 6	−19 12	4.29 B_3	0.034	+ .010± .010		−0.077	−0.011	M
146	ν Scorp. CD	16 6	−19 12	6.49 A	0.014	+ .042± .015		−0.057	−0.004	M
147	49 Serp. A	16 8	+13 47	7.1 K_0	0.459	+ .075± .010	.047	+0.213	+0.169	M
148	49 Serp. B	16 8	+13 47	7.3 K_0	0.459	+ .073± .011		+0.205		M
149	δ Ophiuchi	16 9	− 3 26	3.03 Ma	0.157	+ .040± .010	.024	−0.020	−0.048	D
150	ϵ Ophiuchi	16 13	− 4 27	3.34 K	0.085	+ .046± .012	.017	+0.102	+0.079	H
151	η Draconis	16 22	+61 44	2.89 G_5	0.062	+ .002± .010	.031	−0.022	−0.018	A
152	λ Ophiuchi	16 25	+ 2 12	3.85 A	0.097	+ .009± .008		−0.047	−0.048	A
153	η Herculis	16 39	+39 6	3.61 K	0.101	+ .047± .008	.024	+0.056	+0.034	Ol
154	α Herculis	17 10	+14 30	3.48 Mb	0.030	+ .006± .008	.002	−0.028	−0.012	F
155	δ Herculis	17 10	+24 57	3.16 A	0.165	+ .016± .009		−0.022	−0.024	M
156	β Draconis	17 28	+52 22	2.99 G	0.016	− .015± .007	.009	−0.024	−0.014	A
157	β Ophiuchi	17 38	+ 4 36	2.94 K	0.157	+ .021± .010	.030	−0.029	−0.041	M
158	μ Herculis	17 42	+27 46	3.48 G_5	0.817	+ .108± .009	.105	−0.258	−0.324	M
159	ν Ophiuchi	17 53	− 9 45	3.50 K	0.119	+ .024± .011	.013	+0.011	−0.012	A
160	γ Draconis	17 54	+51 30	2.42 K_5	0.027	.000± .006	.039	+0.028	•−0.008	Ol

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
161	Barnard's Star	17^h54^m	+ 4°25′	9.7 Mb	10″.3	+0″.539±0″.008		−0″.715		M
162	70 Ophiuchi A.....	18 0	+ 2 30	4.07 K_0	1.131	+ .173± .007	+0″.195	+0.137	+0″.253	M
163	70 Ophiuchi B.....	18 0	+ 2 30	6.1 K_6	1.131	+ .184± .009	.153	+0.385	+0.253	L
164	99 Herculis.....	18 3	+30 32	5.21 F	0.113	+ .044± .010	.061	−0.082	−0.095	M
165	Schjellerup 16.....	18 14	− 5 0	7.8		− .004± .006		+0.094		H
166	χ Draconis.....	18 22	+72 41	3.69 F_8	0.638	+ .090± .011	.115	+0.435	+0.495	Ol
167	110 Herculis.....	18 41	+20 27	4.26 F_5	0.345	+ .060± .009	.058	+0.002	−0.021	A
168	γ Lyræ.....	18 55	+32 33	3.30 A	0.007	+ .007± .009		−0.003	−0.002	A
169	ζ Sagittarii.....	18 56	−30 1	2.71 A_2	0.022	+ .018± .008		+0.066	+0.022	Ol
170	ζ Aquilæ.....	19 1	+13 43	3.02 A	0.102	+ .027± .010		−0.023	−0.009	Ol
171	π Sagittarii.....	19 3	−21 10	3.02 F_2	0.040	+ .012± .012	.003	−0.032	−0.005	Ol
172	Aquil. 59 Bt.....	19 8	+16 41	6.44 A	0.03	− .004± .008		+0.016		M
173	Aquil. 59 Ft.....	19 8	+16 41	7.9 G_0	0.243	+ .016± .011	.021	+0.054	+0.138*	M
174	Σ 2481 A.....	19 8	+38 37	8.0 G_5	0.267	+ .046± .011	.025	−0.196	−0.226*	M
175	Σ 2481 BC = Se_2....	19 8	+38 37	8.0 G_5	0.267	+ .018± .010	.025	−0.304	−0.226*	M
176	Cygni 6 A.....	19 10	+49 40	6.62 K	0.63	+ .051± .006	.061	−0.227	−0.188	M
177	Cygni 6 B.....	19 10	+49 40	6.84 K	0.654	+ .036± .007	.050	−0.281	−0.173	M
178	ρ Sagittarii.....	19 15	−18 2	3.95 F	0.031	+ .044± .010	.030	−0.007	−0.024	B
179	δ Aquilæ.....	19 20	+ 2 54	3.44 F	0.264	+ .041± .010	.043	+0.270	+0.253	Ol
180	31 b Aquilæ	19 20	+11 43	5.23 G_5	0.96	+ .074± .010	.091	+0.729	+0.725	B

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boas.	
181	β^1 Cygni	19^h26^m	$+27°45'$	3.24 Kp	$0''.014$	$-0''.006 \pm 0''.010$	$+0''.024$	$-0''.011$	$-0''.011$	Ol
182	β^2 Cygni	19 26	+27 45	5.36 B_0	0.009	.000± .006		−0.011	−0.003	Ol
183	Lal. 37120	19 29	+32 58	6.61 G_0	0.517	+ .042± .007	.031	−0.473	−0.472	B
184	σ Draconis	19 32	+69 27	4.78 K	1.82	+ .181± .007	.149	+0.558	+0.557	A
185	θ Cygni	19 33	+49 59	4.64 F_5	0.249	+ .080± .011	.053	+0.055	−0.028	Ol
186	α Sagittæ	19 35	+17 47	4.37 G	0.036	− .009± .008	.003	+0.017	+0.016	G
187	16^1 Cygni	19 39	+50 17	6.26 F	0.217	+ .036± .009	.053	−0.143	−0.155	M
188	16^2 Cygni	19 39	+50 17	6.37 F_5	0.220	+ .030± .011	.039	−0.123	−0.132	M
189	γ Aquilæ	19 41	+10 22	2.80 K_2	0.014	+ .029± .011	.027	+0.001	+0.013	A
190	Σ 2580 A	19 42	+33 29	5.03 F_5	0.452	+ .057± .009	.033	−0.007	+0.010	M
191	Σ 2580 B	19 42	+33 29	8.1	0.452	+ .042± .008	.043	+0.007		M
192	Σ 2576 AB	19 42	+33 23	8.5 K_0	0.433	+ .036± .008	.061	−0.034	+0.016*	M
193	α Aquilæ	19 45	+ 8 36	0.89 A_5	0.64	+ .218± .007		+0.546	+0.536	M
194	η Aquilæ	19 47	+ 0 45	3.7 G_0 4.4	0.012	− .001± .009	− .002	+0.018	+0.008	A
195	ξ Aquilæ	19 49	+ 8 12	4.86 G_5	0.126	+ .034± .009	+ .010	+0.095	+0.095	Ol
196	β Aquilæ	19 50	+ 6 9	3.90 K_0	0.484	+ .066± .011	.095	+0.018	+0.035	M
197	Lal. 38287	19 58	+15 20	7.19 G_5	0.608	+ .078± .006	.043	−0.162	−0.171*	Ol
198	Lal. 38383	19 59	+23 5	7.20 K_0	1.369	+ .075± .009	.071	−1.017	−1.030*	A
199	B. D. 36°.3883	20 4	+36 17	7.44 K_5		− .009± .010	.002	+0.012		Ol
200	Lal. 38183	20 6	+15 53	7.3 G_5	0.55	+ .054± .013		−0.390		H

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. —0.″005.	Obs.	Boss.	
201	o^1 Cygni	20^h10^m	+46°30′	4.96 A_2	0″.017	+0″.022±0″.009		−0″.020	+0″.015	A
202	o^2 Cygni	20 10	+46 26	3.95 Kp	0.002	− .002± .013	+0″.011	+0.001	+0.002	A
203	α^1 Capricorni	20 12	−12 49	4.55 G	0.016	− .017± .009	− .002	+0.025	+0.015	Ol
204	α^2 Capricorni	20 12	−12 51	3.77 K	0.058	− .017± .013	+ .021	+0.032	+0.058	Ol
205	β^1 Capricorni	20 15	−15 6	3.25 Gp	0.035	+ .002± .008	.021	−0.007	+0.035	M
206	β^2 Capricorni	20 15	−15 6	6.16 A	0.042	.000± .010		+0.006	+0.042	M
207	γ Cygni	20 18	+39 56	2.32 F_8p	0.003	−0.003±0.010		+0.004	+0.001	H
208	ρ Capricorni	20 23	−18 8	4.96 F	0.026	+ .019± .013	.006	+0.001	−0.014	M
209	Boss 5247	20 23	−18 12	7.1	0.136	+ .011± .010		+0.057	+0.040	M
210	41 Cygni	20 25	+30 2	4.09 F_5	0.010	− .023± .006	.023	+0.016	+0.009	D
211	β Delphini	20 33	+14 14	3.72 F_5	0.113	+ .008± .008	.041	+0.118	+0.108	Ol
212	52 Cygni	20 41	+30 21	4.34 G_5	0.028	+ .009± .009	.019	−0.028	−0.016	L
213	γ Delphini Bt.	20 42	+15 46	4.49 G_5	0.207	+ .038± .009	.016	−0.108	−0.033	M
214	γ Delphini Ft.	20 42	+15 46	5.47 G_5	0.195	+ .046± .008	.027	−0.078	−0.020	M
215	ϵ Cygni	20 42	+33 35	2.64 K_0	0.483	+ .039± .008	.039	+0.356	+0.360	M
216	η Cephei	20 43	+61 27	3.59 K_0	0.826	+ .064± .013	.078	+0.104	+0.097	B
217	μ Aquarii	20 47	− 9 21	4.80 F	0.052	+ .005± .008		+0.058	+0.037	Ol
218	ϵ Equul. AB	20 54	+ 3 55	5.29 F_5	0.191	+ .021± .010	.016	−0.125	−0.126	M
219	ϵ Equul. C	20 54	+ 3 55	7.1	0.191	+ .002± .011	.010	−0.135	−0.126	M
220	W. B. $20^h.1454$	20 59	+ 2 36	8.0 F_8	0.485	+ .005± .009	.010	−0.289	−0.297*	Ol

TABLE 5.—*Continued.*

No.	Star.	R. A. 1900.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
221	61^1 Cygni	$21^h\ 2^m$	+38°15′	5.57 K_5	5″.271	+0″.306±0″.005	+0″.317	+4″.161	+4″.148	M
222	61^2 Cygni	21 2	+38 15	6.28 K_5	5.157	+ .308± .006	.283	+4.161	+4.134	M
223	ζ Cygni	21 8	+29 49	3.40 K_0	0.059	+ .028± .010	.008	−0.002	−0.003	A
224	τ Cygni	21 10	+37 37	3.82 F_0	0.454	+ .046± .007	.037	+0.159	+0.158	F
225	δ Equulei	21 10	+ 9 36	4.61 F_5	0.306	+ .041± .007	.055	+0.029	+0.041	Ol
226	α Cephei	21 16	+62 9	2.60 A_5	0.160	+ .091± .008		+0.154	+0.152	Ol
227	β Aquarii	21 26	− 6 0	3.07 G	0.016	− .001± .012	.013	+0.005	+0.014	B
228	γ Capricorni	21 34	−17 6	3.80 Fp	0.188	+ .013± .009	.030	+0.169	+0.187	Ol
229	76 Cygni	21 37	+40 21	6.05 A	0.052	+ .005± .012		−0.030	−0.010	A
230	ϵ Pegasi	21 39	+ 9 25	2.54 K_0	0.025	+ .017± .008	.023	+0.022	+0.025	Ol
231	μ Cygni	21 39	+28 17	4.73 F_5	0.371	+ .041± .010	.053	+0.330	+0.283	M
232	κ Pegasi	21 40	+25 11	4.27 F_5	0.033	+ .016± .008	.031	+0.010	+0.032	M
233	δ Capricorni	21 41	−16 34	2.98 A_5	0.392	+ .110± .012		+0.262	+0.258	H
234	22 Pegasi	22 0	+ 4 34	4.90 Kp	0.138	+ .012± .008	+ .007	+0.090	+0.103	D
235	α Aquarii	22 0	− 0 48	3.19 G_0	0.015	+ .005± .010	− .001	+0.002	+0.014	M
236	ι Pegasi	22 2	+24 51	3.96 F_5	0.299	+ .091± .008	+ .082	+0.273	+0.299	Ol
237	ζ Cephei	22 7	+57 42	3.62 K	0.013	+ .019± .010	.019	+0.011	+0.011	Ol
238	ϵ Cephei	22 11	+56 32	4.22 A_5	0.153	+ .053± .008		+0.462	+0.450	H
239	Lal. 43492	22 12	+12 24	6.94 G_0	0.853	+ .052± .007	.053	+0.839	+0.847*	A
240	ζ^1 Aquarii	22 23	− 0 31	4.42 F_5	0.173	+ .034± .013	.023	+0.156	+0.172	

TABLE 5.—*Continued.*

No.	Star.	R. A. 1800.	Decl. 1900.	Magn. and Spect.	μ.	Parallax.		Proper Motion.		Meas.
						McCormick.	Spect. $-0''.005$.	Obs.	Boss.	
241	ζ^2 Aquarii	22^h23^m	$-\ 0°31'$	4.59 F_5	$0''.212$	$+0''.029\pm0''.010$	$+0''.024$	$+0''.166$	$+0''.207$	A
242	Krueger 60 A	22 24	+57 11	9.3 Mb	0.94	$+\ .267\pm\ .011$	.185	−0.671	−0.797*	M
243	Krueger 60 B	22 24	+57 11	10.8	0.94	$+\ .265\pm\ .014$		−0.946	−0.797*	M
244	Krueger 60 C	22 24	+57 11	9.2		$+\ .001\pm\ .010$		+0.006		M
245	η Pegasi	22 38	+29 42	3.10 G_0	0.036	$-\ .008\pm\ .010$	.017	−0.058	+0.010	Ol
246	ξ Pegasi	22 41	+11 39	4.31 F_5	0.54	$+\ .046\pm\ .011$	.074	+0.205	+0.227	L
247	μ Pegasi	22 45	+24 4	3.67 K_0	0.154	$-\ .006\pm\ .012$	.025	+0.167	+0.147	A
248	ι Cephei	22 46	+65 40	3.68 K_0	0.139	$+\ .048\pm\ .008$	.025	−0.091	−0.068	A
249	Lal. 45028	22 56	− 4 23	7.60 K_0	0.478	$+\ .053\pm\ .011$	.041	+0.405	+0.418*	Ol
250	β Pegasi	22 58	+27 32	2.61 Mb	0.234	$-\ .005\pm\ .006$	.025	+0.197	+0.192	Ol
251	7 Androm	23 8	+48 51	4.62 F	0.137	$+\ .033\pm\ .010$	.030	+0.088	+0.095	Ol
252	W. B. 23^h 175	23 12	−14 21	8.3 F_8	1.305	$+\ .028\pm\ .007$		−0.534	−0.490*	M
253	Lal. 45585	23 12	− 2 4	8.5	0.265	$+\ .025\pm\ .013$		+0.235	+0.249	Ol
254	γ Piscium	23 12	+ 2 44	3.85 K_0	0.753	$+\ .044\pm\ .010$	.017	+0.748	+0.750	Ol
255	Lal. 45638	23 14	+ 4 52	8.6 G_5	0.492	$+\ .005\pm\ .007$	.039	+0.487	+0.479*	M
256	υ Pegasi	23 20	+22 51	4.57 G_0	0.191	$+\ .007\pm\ .009$	.016	+0.194	+0.189	L
257	ι Piscium	23 34	+ 5 5	4.28 F_5	0.574	$+\ .067\pm\ .007$	.078	+0.361	+0.370	A
258	Boss 6129	23 47	+74 59	6.55 K	0.332	$+\ .088\pm\ .008$	.100	+0.315	+0.329	D
259	ρ Cassiopeiæ	23 49	+56 57	4.85 F_8p	0.007	$+\ .041\pm\ .010$		−0.028	−0.005	A
260	Boss 6142	23 50	+56 51	6.05 Bp	0.006	$+\ .025\pm\ .010$		−0.008	−0.005	A
261	ω Piscium	23 54	+ 6 19	4.03 F_5	0.185	$+\ .018\pm\ .009$	$+\ .041$	+0.135	+0.149	G

PART II.

MEASURES OF DOUBLE STARS ON PARALLAX PLATES

BY

CHARLES P. OLIVIER.

From the beginning of the work of the determination of parallaxes by photography at the McCormick Observatory it has been the intention of Director S. A. Mitchell to utilize the plates for other purposes than the determination of parallax, although this was the principal program.

Although no attempt was specially made to select double stars for the parallax program as has been the case at Sproul Observatory, nevertheless quite a number of the stars whose parallax was sought were doubles. Where the rotating sector was utilized to cut down the brightness of the parallax stars it frequently happened that the fainter star was so decreased in brightness that its image was invisible. In many regions photographed, however, both components of the double star appeared on the plates.

In photographing, each McCormick plate covered an area in the sky 1° in length parallel to the celestial equator, and three-quarters of a degree at right angles thereto, and since these plates cover such a considerable area, it is only natural that many doubles should be photographed on them. Many of these doubles thus accidentally photographed were already known, but quite a number of them are new discoveries.

The actual measurement of the photographs to determine the position angle and distance of these double stars, old and new, were undertaken independently by Dr. H. L. Alden and the writer. Later it was decided that Dr. Alden should devote his

energies to other fields of astronomical work. The measurements herewith given are exclusively those of the writer.

The idea of measuring doubles upon photographic plates is an old one, and has been tried often before with more or less success. For wider pairs excellent results were obtained, but as the 5″ limit was reached most of the observers found large errors. For example in *The Observatory*, June, 1917, p. 233–236, Mr. R. Jonckheere discusses three astrographic catalogues containing double star measures. He was able to compare one of these, namely the one made at Potsdam, Zone + 31° to + 40°, with visual measures. His conclusions were that the measures showed large discordances from plate to plate and also large disagreements from visual measures; further, that many of the doubles could not be found in a visual search with the Greenwich 28-inch. In other words such measurements of photographs are useless for inclusion in a double star catalogue.

In the *Monthly Notices R. A. S.* for April, 1917, there is an extensive paper by Mr. F. A. Bellamy on this subject. From a close study of the Oxford astrographic plates he finds that while there is a good agreement in the angles, for all distances, with the best visual measures, yet in the distances very large systematic errors enter for stars of 5″.0 and under. He concludes,—"however useful photography may be for wider pairs, it cannot at present replace visual work for close pairs." Since these are both very recent papers, it seems unnecessary to quote from older ones on the same subject.

Before giving the results of the McCormick measures, some preliminary statements should be made. First, the plates were in all cases taken to determine parallaxes, not to furnish the best images of doubles. Hence, unless the parallax star happened itself to be double, the exposures were never timed to give the best sized images. For other doubles that happened to be on the plates it should be understood that no special effort was made to photograph these stars under good conditions of seeing when they would be better separated, nor were the stars placed near the center of the plate. In brief, the measures of doubles come as an additional by-product, no special photographs having been made for the purpose.

This paper contains the measures of 95 pairs, and estimates of four others which were merely elongated on the best plates. Since these four are new these estimates will aid in future identification. Altogether 32 pairs were discovered on the plates where the separation is less than 5″, and ten others with a greater angular distance.

The measures were always made in X and Y coordinates from which the position angle and distance were calculated. These measures were made in both the direct and reversed positions of the plate, personal experience having proved at the very beginning that measures in one position only might be subject to considerable errors. The scale of the plates is 1 mm. = 20″.8. The standard plate of each region contains a trail obtained by stopping the clock and allowing a bright star to pass across the field. The parallels for the other plates were obtained by merely tracing this trail, through the glass, in ink. This introduced a purely accidental error, which usually amounted to a few tenths of a degree. The results prove that this practice which saved the immense amount of time that more careful orientation would have required, had no harmful results.

Two images of every star appear on most of the plates. But frequently one was unsuitable for measurement due to a sudden change for the worse in seeing, elongated images, etc. In such cases only one image was used. The plate was then denoted by an asterisk (*), and weighted one half. When both images were measured it was weighted unity. The 32 new doubles found on our plates are in each case designated by the name or initials of the person who first detected them. A number has been given only to those whose distances are less than 5″. The ten new double stars separated over 5″ are followed by (*r*) which means that none of our staff cares to announce stars wider than 5″ as "doubles," but since it was more or less necessary to assign them to the person who first noted them, his name accompanies each such star, the (*r*) meaning it was rejected as a discovery. Yet the measures of a few such pairs are not without interest in this preliminary work on the subject, hence the results are retained.

During the early stages of the work many plates of each double

were measured because it was desired to find how small the residuals would be. Later only enough were measured to give a result of the desired accuracy. In some cases only one plate of the whole series had long enough exposure in good enough seeing to show the double plainly. For certain binary stars several plates in each epoch were measured, since nothing could prove better the accuracy of these results than a comparison of such measures with accurate orbits, based upon the former visual observations. Special attention is called to the measures of 70 Ophiuchi and Krueger 60 in this connection. The plates of Krueger 60 were independently measured by Director S. A. Mitchell. The measures from the photographs were compared with measures made visually by Professor E. E. Barnard with the 40-inch Yerkes refractor, which measures were kindly sent by Professor Barnard for comparison. In 1919, the components AB were separated by an angle of 1".8, or less than 0.1 mm. on the McCormick photographs. Although this a rather easy object in a telescope the size of the 40-inch, and a more difficult one on the photographs owing to the scale of the photographs, comparisons with the visual measures of Professor Barnard show that the photographic measures agree among themselves quite as well as do the visual measures, and moreover the position angles and distances from the photographs agree perfectly with the visual measures, no systematic error of any sort being discoverable. In other words, measures of doubles from photographs taken with the 26-inch McCormick refractor are quite as accurate as are visual measures made with the filar micrometer attached to the same refractor. A more complete discussion of the measures of Krueger 60 appears in the *Astronomical Journal*, 766.

The measurements of doubles on the photographs where the separation is greater than 3" should be classed as "easy." With a closer separation, the measures become more difficult. If there is not too much difference in magnitude, stars separated 2" are not difficult. A and B of Krueger 60 differ one and a half magnitudes. One of the doubles discovered on the plates, Alden 1, was measured by him to be separated 1".66. The mean of three nights at the telescope visually by the writer gave

1".63. One or more of the elongated stars are probably about 1".2. Two of the later discoveries, Ol 76 and Ol 78, were measured on the plates as 1".35 and 1".36, respectively, but these distances have not been checked visually.

When possible all measures have been compared with Burnham's General Catalogue. Most of them agree quite as well with the visual measures as the latter agree among themselves. But there are obvious difficulties in making out a table of differences, for the question arises *which* measures in Burnham, when they are discordant, are we to compare with? Short notes following the measures, give the more striking results of individual comparisons. Only for β GC 9114 is there a really curious difference. Though the double on the plates is widely separated and easy to measure, and the visual measures in Burnham are accordant, yet my distances are 0".5 wider. For this case I have no present explanation. A similar holds for β GC 9574, but here there is a magnitude difference of 2.2, which might explain the matter.

As a result of these measures the conclusions are:

1. Without special care it is possible to discover and measure on the average McCormick plates any double of 3" or wider, as faint as the 11th magnitude, if the components do not differ more than two magnitudes.

2. With good seeing and with exposures specially timed for the purpose a double of 2" is an "easy" object.

3. If the components are nearly equal in magnitude it would be possible to measure stars separated 1".5, or under special circumstances, stars as close as 1".0.

4. No evidence of any systematic errors is found in the measures of doubles on the McCormick plates.

5. The present paper probably offers the first published proof that measures of close doubles can be made from photographs which are comparable in accuracy with the best visual measures, and hence a rather extensive field is thus opened up for the double star astronomy of the future.

Double star observers are familiar with the arrangement in the tables below. Immediately following the name of the star is its number in Burnham's *General Catalogue*, and enclosed in

square brackets [ ] if the star is found there. A star from Jonckheere's catalogue is given as { }. The magnitudes of the components are next given, and then follow the right ascension and declination for 1920. The measures of the plate give the plate number, the initial of the observer at the telescope, the time in years added to 1900, and the position angle and distance.

Σ 3057 [12735] 7.2–9.2

R.A. 0h 0m 46s Decl. +58° 5′

7546	D	19y.644	297°.5	4″.16
7547	D	19.644	298.3	4.16
		19.644	297.9	4.16

E 315 {84} 10–11

R.A. 0h 33m 33s Decl. +28° 46′

6018	M	18.906	77.4	2.26
6017	M	18.906	80.8	2.32
		18.906	79.1	2.29

A 2203 {89} 9–11

R.A. 0h 35m 22s Decl. +2° 52′

6193	M	19.022	.....	2.22
6194	F	19.022	122.6	2.33
6251	D	19.041	121.8	2.28
		19.028	122.2	2.28

η Cassiopeiæ [426] 3.6–7.6

R.A. 0h 44m 15s Decl. +57° 24′

554	G	14.863	250.2	6.66
584	M	14.877	248.8	6.64
660	A	14.948	251.6	6.80
		14.896	250.2	6.70
4364	B	17.658	255.5	7.08
4373	B	17.661	253.8	6.90
4374	B	17.661	253.3	7.02
		17.660	254.2	7.00
4840	M	17.921	253.7	7.01
4841	M	17.921	255.2	7.14
4847	A	17.929	254.5	6.84
		17.924	254.5	7.00

Angle and distance both increasing.

S 390 [513] 9–10

R.A. 0h 54m 11s Decl. +16° 7′

8167	Ol	19.917	214.9	6.38
8168	Ol	19.917	215.2	6.32
		19.917	215.0	6.35

A 1909 {221} 9–9.2

R.A. 1h 25m 14s Decl. +21° 31′

6301	D	19.058	126.6	1.69
6302*	D	19.058	121.2	1.65
7505	D	19.630	127.9	1.69
		19.297	126.0	1.67

Alden (r) 9.3–10.6

R.A. 1h 30m 39s Decl. +40° 58′

3561	M	17.017	7.1	5.64
3662	M	17.017	7.2	5.64
		17.017	7.2	5.64

84 Ceti [1386] 6.0–9.2

R.A. 2h 37m 6s Decl. −1° 2′

4448	A	17.717	318.2	4.41
4449	A	17.717	314.6	4.48
		17.717	316.4	4.44

Angle and distance decreasing.

Σ 305 [1427] 7.3–8.2

R.A. $2^h\ 42^m\ 56^s$			Decl. +19° 2′	
4424	A	17.699	315.2	3.52
4425	A	17.699	315.7	3.54
4475	B	17.737	315.1	3.78
4491	B	17.751	315.4	3.40
		17.722	315.4	3.56

Distance increasing.

Σ 422 [1787] 6.2–8.2

R.A. $3^h\ 32^m\ 41^s$			Decl. +0° 20′	
1700	M	15.706	251.3	6.25
1770	M	15.752	251.3	6.35
1771*	M	15.752	250.6	6.45
2988	M	16.689	251.7	6.34
3642	M	17.102	252.2	6.26
3643	M	17.102	252.8	6.38
		16.405	251.7	6.33

S.A.M. 1 10–12

R.A. $3^h\ 32^m\ 52^s$			Decl. +0° 27′	
1700	M	15.706	176.4	3.98
1770*	M	15.752	176.0	4.18
1771*	M	15.752	175.7	3.81
3642	M	17.102	173.8	4.30
		16.187	175.4	4.09

Alden 1 9.2–9.6

R.A. $3^h\ 37^m\ 0^s$			Decl. −3° 39′	
4429	A	17.698	144.7	1.65
4429	A	17.698	134.9	1.39

First of these measures by Alden.

A 1541 9.2–10.2

R.A. $3^h\ 38^m\ 49^s$			Decl. +42° 14′	
777	M	15.027	251.2	4.14
778	M	15.027	250.8	4.28
1618	Ol	15.684	252.2	4.30
3619	L	17.072	252.2	4.08
		15.702	251.6	4.20

Σ 443 [1854] 8.2–8.8

R.A. $3^h\ 41^m\ 35^s$			Decl. +41° 15′	
4504	A	17.754	49.5	8.38
4505	A	17.754	49.5	8.34
4550	A	17.773	49.5	8.30
		17.760	49.5	8.34

Very slow increase in angle, decrease in distance.

32 Eridani [1939] 5.0–6.3

R.A. $3^h\ 50^m\ 16^s$			Decl. −3° 12′	
3147	M	16.768	347.0	6.78
4520	A	17.762	345.9	6.81
4543	Ol	17.767	345.5	6.82
		17.432	346.1	6.80

Fixed.

β 309 [2044] 8.0–11.3

R.A. $4^h\ 3^m\ 41^s$			Decl. +19° 32′	
361	A	14″.748	278°.8	5″.87
531	G	14.858	278.4	6.12
762	G	15.021	278.9	6.21
886	G	15.125	278.6	5.94
2360*	A	16.092	278.2	6.17
		15.063	278.6	6.05

Fixed.

o^2 Eridani [2109] 9.1–10.8

R.A. $4^h\ 11^m\ 48^s$			Decl. −7° 41′	
875	G	15.112	23.6	2.92
876	G	15.112	26.3	2.96
934	A	15.142	26.8	3.22
935	M	15.145	28.2	3.00
936	G	15.145	26.1	3.00
		15.131	26.2	3.02

Binary.

Ol 66 10–10.1

R.A. $4^h\ 29^m\ 52^s$		Decl. $+16°\ 20'$		
3151	M	16.768	148.2	4.46
4550	A	17.773	149.9	4.46
4551	A	17.773	148.6	4.36
		17.438	148.9	4.43

Weisse 4 [2288] 9.0–9.1

R.A. $4^h\ 34^m\ 30^s$		Decl. $+42°\ 11'$		
4637	M	17.819	112.1	2.28

S.A.M. 2 9.5–11.5

R.A. $5^h\ 9^m\ 52^s$		Decl. $-9°\ 2'$		
6473	D	19.101	258.3	5.17
6641	D	19.181	259.7	5.10
6642	D	19.181	258.4	5.15
		19.154	258.8	5.14

E 281 {836} 9.0–9.6

R.A. $5^h\ 14^m\ 55^s$		Decl. $+40°\ 15'$		
4528	M	17.765	211.3	2.51
4720	D	17.850	212.6	2.16
4769	B	17.877	214.1	2.20
		17.831	212.7	2.29

No sensible motion.

Fox 7 (?) {902} 9.5–11

R.A. $5^h\ 27^m\ 47^s$		Decl. $-3°\ 18'$		
5716	M	18.726	42.7	2.62
6600	D	19.170	46.0	2.76
6601	D	19.170	45.5	2.71
		19.022	44.7	2.70

The position as given by Fox probably in error.

S.A.M. 3 10–.10

R.A. $5^h\ 50^m\ 49^s$		Decl. $+45°\ 4'$		
3749	M	17.188	30±	1.2±

Ol 67 9.5–9.8

R.A. $6^h\ 15^m\ 17^s$		Decl. $-2°\ 48'$		
3163	A	16.776	109.0	3.33
3360	L	16.853	109.7	3.08
3361	L	16.853	108.3	3.03
3423	L	16.891	109.4	3.18
		16.843	109.1	3.16
5885	M	18.846	110.1	3.28
5886	M	18.846	110.3	3.13
6477	D	19.101	111.0	3.13
		18.931	110.5	3.18

Ol 68 9.5–10

R.A. $6^h\ 18^m\ 10^s$		Decl. $+22°\ 12'$		
4574	B	17.784	37.7	4.95

Ol (*r*) 9.2–10.4

R.A. $6^h\ 18^m\ 32^s$		Decl. $+22°\ 12'$		
4574	B	17.784	55.2	6.52

A.G. 115 [3399] 8.8–9.1

R.A. $6^h\ 25^m\ 9^s$		Decl. $+30°\ 30'$		
8088*	Ol	19.878	353.9	4.24
8116	F	19.887	352.6	4.22
8117	F	19.887	354.2	4.24
		19.885	353.6	4.23

S.A.M. 4 10–10.5

R.A. $6^h\ 51^m\ 8^s$		Decl. $+1°\ 36'$		
5981	D	18.871	153.4	1.79
5982	H	18.871	154.1	1.90
		18.871	153.8	1.84

S.A.M. 5 10–10.5

R.A. $6^h\ 52^m\ 28^s$ Decl. $+1°\ 7'$

5981	D	18.871	272.6	3.65
5982	H	18.871	274.2	3.84
6750	D	19.230	272.1	3.72
		18.991	273.0	3.74

Ho 33 [3968] 9–12

R.A. $7^h\ 15^m\ 15^s$ Decl. $+22°\ 19'$

536	G	14.858	320.2	2.51
1088	G	15.213	325.2	2.64
3325	A	16.837	323.9	2.65
3768	Ol	17.381	325.6	2.68
4830	B	17.918	328.2	2.69
		16.441	324.6	2.63

Fixed?

α GEMINORUM [4122] 2.0–2.8

R.A. $7^h\ 29^m\ 30^s$ Decl. $+32°\ 4'$

1931*	M	15.829	219.2	5.45
1966	M	15.843	218.6	5.38
1967	M	15.843	218.5	5.38
2106*	M	15.925	219.7	5.36
		15.854	218.8	5.39
4553	A	17.773	217.0	5.25
4554	A	17.773	218.2	5.26
4660	A	17.789	217.9	5.35
4684*	M	17.833	218.2	5.34
		17.786	217.8	5.29

Binary.

S.A.M. 6 10–11

R.A. $7^h\ 33^m\ 45^s$ Decl. $+5°\ 24'$

1932	M	15.191	74.2	2.54
1933*	M	15.191	70.2	2.32
2460	A	16.191	69.8	2.51
2461	A	16.191	71.5	2.65
2554*	M	16.262	71.3	2.59
		15.825	71.6	2.54

OL 69 11–12

R.A. $7^h\ 48^m\ 1^s$ Decl. $-13°\ 54'$

3269	M	16.815	121.7	3.04

OL 70 11.5–12

R.A. $7^h\ 49^m\ 15^s$ Decl. $-13°\ 52'$

3269	M	16.815	133.8	4.80

OL 71 B.D. $-11°.2299$ 9–11

R.A. $8^h\ 12^m\ 38^s$ Decl. $-11°\ 35'$

3304	M	16.826	317.3	2.59
3306*	M	16.826	321.3	2.65
3770	Ol	17.214	320.2	2.76
3771	Ol	17.214	320.2	2.75
3889*	Ol	17.294	322.8	2.29
6751	D	19.230	321.1	2.57
		17.509	320.3	2.63

2 CANCRI [4763] 4.2–6.6

R.A. $8^h\ 41^m\ 52^s$ Decl. $+29°\ 3'$

620*	A	14.892	307.4	30.75
633	G	14.895	307.9	30.74
680	G	14.958	307.0	30.82
		14.920	307.4	30.77
3797	M	17.227	307.3	30.80
3798	M	17.227	307.0	30.92
3828	L	17.240	307.2	30.86
		17.231	307.2	30.86

Angle constant, distance increasing.

Σ 1280 [4815] 7.5–7.6

R.A. $8^h\ 47^m\ 59^s$ Decl. $+71°\ 8'$

6785	M	19.244	40.2	4.58
6808	M	19.252	47.2	4.54
6809	M	19.252	48.9	4.42
		19.249	45.4	4.51

Rapid motion.

Ol 72 10–11

R.A. $9^h\ 12^m\ 27^s$			Decl. +37° 3′	
5292*	A	18.284	63.0	2.47
8144*	M	19.903	57.7	2.14
		19.094	60.4	2.30

Σ 1334 [5014] 4.0–6.7

R.A. $9^h\ 13^m\ 53^s$			Decl. +37° 9′	
5292	A	18.284	233.0	2.82
6753	D	19.229	234.3	2.72
8125	F	19.887	240.0	2.79
		19.133	235.8	2.78

Ol (*r*) 9–9.5

R.A. $9^h\ 45^m\ 26^s$			Decl. −12° 42′	
6160	M	18.994	79.7	5.41
6161	M	18.994	79.3	5.30
6747	F	19.227	78.2	5.41
		19.072	79.1	5.37

γ Leonis [5388] 2.6–3.8

R.A. $10^h\ 15^m\ 32^s$			Decl. +26° 59′	
3504	M	16.935	117.0	3.90
3507	M	16.935	116.9	4.09
3912	A	17.310	116.0	4.07
3913	A	17.310	116.3	3.92
3920	M	17.332	113.9	3.86
3921	M	17.332	120.0	3.83
		17.216	116.7	3.93

Confirms Burnham that system is not a binary.

γ Virginis [6243] 3.6–3.6

R.A. $12^h\ 37^m\ 40^s$			Decl. −1° 0′	
5*	M	14.354	325.0	6.16
18	M	14.370	323.6	6.00
37	M	14.392	324.7	5.83
51	M	14.412	326.0	5.96
55	M	14.414	323.8	5.96
56	M	14.414	323.8	5.94
		14.395	324.2	5.97

Rapid binary.

Alden 2 11–11.5

R.A. $13^h\ 9^m\ 54^s$			Decl. +28° 8′	
3702	Ol	17.150	160±	1.4±

Σ 1733 [6438] 8.2–9.8

R.A. $13^h\ 12^m\ 25^s$			Decl. +17° 40′	
6168	M	18.994	142.7	4.76
6214	D	19.028	145.4	4.82
7199	M	19.466	143.6	4.78
		19.163	143.9	4.79

β 117 [6896] 8.3–9.2

R.A. $14^h\ 26^m\ 54^s$			Decl. −15° 15′	
723	G	14.988	83.1	2.02
815	G	15.055	87.7	2.38
3722	L	17.178	87.0	2.41
6468	M	19.099	90.3	2.22
6279	D	19.052	89.5	1.98
7162	F	19.422	90.3	2.04
		17.466	88.0	2.17

Ol 73 9.8–11.5

R.A. $14^h\ 30^m\ 49^s$			Decl. −11° 42′	
6786	F	19.244	105.7	2.82
6787	F	19.244	107.8	3.05
7185	F	19.433	112.7	3.30
7186	F	19.433	109.0	3.11
		19.338	109.2	3.11

Σ 1955 [7313] 8.7–9.3

R.A. $15^h\ 30^m\ 28^s$			Decl. +26° 59′	
1101	G	15.221	239.1	7.78
2741	M	16.472	238.6	7.89
2742	L	16.472	238.2	7.76
		16.055	238.6	7.81

Fixed.

S.A.M. (*r*) 8–9.5
R.A. $15^h\ 40^m\ 55^s$ Decl. +15° 33′

1403	G	15.487	321.4	6.36
1404	G	15.487	319.6	6.31
1431	Ol	15.511	320.7	6.42
2385	G	16.103	319.9	6.44
2814	M	16.530	321.7	6.44
4112	M	17.477	320.1	6.32
4113	B	17.477	321.4	6.36
		16.356	320.7	6.37

Alden 3 B.D. +15°.2936 9.5–9.8
R.A. $15^h\ 54^m\ 33^s$ Decl. +15° 47′

2534	A	16.243	45±	1.5±

ξ Scorpii [7487] (4.9+5.2)–7.2
R.A. $15^h\ 59^m\ 58^s$ Decl. −11° 10′

114	Ol	14.518	60.5	7.47
129	M	14.528	60.1	7.34
1423	A	15.500	61.9	7.54
1424	A	15.500	61.3	7.33
1453	G	15.525	61.3	7.60
		15.179	61.1	7.47

Angle decreasing, distance increasing.

Σ 1999 [7488] 7.4–8.1
R.A. $16^h\ 0^m\ 2^s$ Decl. −11° 14′

114	Ol	14.518	100.4	11.42
129	M	14.528	100.0	11.43
1423	A	15.500	100.2	11.37
1424	A	15.500	100.3	11.32
1453	G	15.525	100.2	11.42
		15.114	100.2	11.39

Angle decreasing, distance increasing.

49 Serpentis [7551] 7.1–7.3
R.A. $16^h\ 9^m\ 38^s$ Decl. +13° 45′

3818	L	17.231	336.4	4.18
3819	L	17.231	335.6	4.12
4077	B	17.461	336.8	4.16
4078	M	17.461	335.1	4.15
		17.346	336.0	4.15

Angle and distance slowly increasing.

σ Coronæ [7563] 5.8–6.6
R.A. $16^h\ 11^m\ 41^s$ Decl. +34° 4′

5315	Ol	18.310	218.7	5.16
5316	Ol	18.310	220.4	5.28
6528*	M	19.129	219.8	5.11
6529	M	19.129	218.2	5.26
6961	F	19.334	219.5	5.07
		18.811	219.3	5.18

Binary.

Ol (*r*) 9.2–11
R.A. $16^h\ 39^m\ 33^s$ Decl. +39° 16′

3886	A	17.290	279.4	5.10
3887*	A	17.290	279.4	4.93
3895	A	17.296	279.9	5.10
5563	A	18.550	278.4	5.23
5574	A	18.553	278.7	5.09
		17.852	279.1	5.09

α Herculis [7914] 3.5–5.4
R.A. $17^h\ 10^m\ 59^s$ Decl. +14° 29′

142	M	14.548	111.8	4.84
1508*	Ol	15.561	113.1	4.83
1509*	Ol	15.561	113.9	4.80
2648	A	16.349	112.6	4.84
2649	A	16.349	112.5	4.72
2817	M	16.530	114.8	4.65
2818	M	16.530	114.0	4.42
		15.978	113.2	4.71

Fixed.

ALDEN (r) 7.8–11.2

R.A. 17h 30m 22s Decl. +52° 40′

5250	A	18.241	348.6	6.08
5251	A	18.241	347.3	6.20
		18.241	348.0	6.12

70 OPHIUCHI [8340] 4.1–6.1

R.A. 18h 1m 26s Decl. +2° 33′

1	M	14.335	36.8	4.32
6	M	14.354	37.8	4.56
7	M	14.354	35.5	4.66
10	M	14.357	37.0	4.50
		14.350	36.8	4.51
249	M	14.706	36.6	4.64
336	M	14.742	38.0	4.76
353	M	14.745	38.1	4.59
365	M	14.750	38.4	4.58
		14.733	37.7	4.63
1183	M	15.280	38.7	4.70
1203	A	15.286	39.2	4.72
2113	M	15.288	38.4	4.70
		15.285	38.8	4.71
3908	L	17.307	43.0	4.98
3909	L	17.307	43.1	5.00
3996	M	17.392	42.5	5.04
3997	M	17.392	41.9	5.02
		17.350	42.6	5.01
4278	B	17.630	43.3	5.14
4279	B	17.630	43.6	5.06
4322	Ol	17.647	42.2	5.22
4323	Ol	17.647	43.2	5.27
		17.638	43.1	5.17

Rapid binary.

SCHJ. 16 [8483] 7.9–9.2

R.A. 18h 15m 31s Decl. −5° 0′

4386	B	17.672	202.5	2.98
5420	L	18.427	203.3	2.80
5421	L	18.427	203.0	2.78
		18.175	202.9	2.85

Motion shown?

ALDEN 4 10.5–11

R.A. 18h 40m 56s Decl. +20° 11′

1566	A	15.637	337.6	3.81
1592	A	15.662	341.3	3.91
4235	B	17.592	338.9	3.85
		16.297	339.3	3.86

OL (r) B.D. +5°.3994 9.5–10

R.A. 18h 54m 39s Decl. +5° 54′

7696	Ol	19.701	106.2	5.65
7697	Ol	19.701	106.4	5.71
		19.701	106.3	5.68

S.A.M. 7 9–11.5

R.A. 19h 7m 6s Decl. +38° 14′

1310*	M	15.681	175.7	3.54
1639	M	15.692	177.9	3.57
1640	Ol	15.692	178.8	3.80
2693	M	15.918	176.7	3.56
		15.894	177.6	3.64

Σ 2481 [9114] 8.0–8.0

R.A. 19h 8m 47s Decl. +38° 39′

1310	M	15.681	217.1	4.87
1639	M	15.692	217.6	4.68
1640	Ol	15.692	214.9	4.66
2693	M	16.418	215.9	4.82
		15.871	216.4	4.76

Angle decreasing, distance increasing.

J 1304 {2885} 9.4–9.7

R.A. 19h 21m 20s			Decl. +11° 28′	
2993	Ol	16.697	55.0	1.74
3139	Ol	16.765	55.7	1.96
4370	A	17.661	58.5	1.79
4371	A	17.661	59.0	2.23
4463	B	17.732	59.7	2.14
		17.303	57.6	1.97

Oʟ (*r*) 10–11

R.A. 19h 26m 16s			Decl. +27° 39′	
8	M	14.354	256.5	7.84
16	M	14.360	255.6	7.44
17	M	14.360	256.7	7.62
1651	M	15.695	255.6	7.60
		14.692	256.1	7.62

Σ 2539 [9394] 7.9–9.7

R.A. 19h 28m 52s			Decl. +28° 6′	
8	M	14.354	3.9	5.87
11	M	14.357	1.6	5.46
16	M	14.360	2.9	5.47
17	M	14.360	1.1	5.69
25*	M	14.376	4.0	5.73
1651	M	15.695	2.1	5.75
		14.603	2.5	5.66

Fixed.

Σ 2563 [9538] 8.3–9.5

R.A. 19h 39m 23s			Decl. +17° 15′	
7899	M	19.763	285.1	6.22
7900	M	19.763	282.3	6.23
		19.763	283.7	6.22

Σ 2570 [9574] 7.3–9.5

R.A. 19h 41m 8s			Decl. +10° 35′	
403	M	14.798	278.1	4.59
1405	A	15.487	277.7	4.78
1623	A	15.687	277.8	4.70
4397	A	15.694	276.0	4.68
		15.416	277.4	4.69

Distance increasing.

Oʟ 74 9.5–9.6

R.A. 19h 42m 15s			Decl. +18° 20′	
3133	L	16.763	167.9	4.28
4555	A	17.778	168.5	4.34
4576	M	17.787	169.9	4.32
		17.443	168.8	4.31

J 150 {3023} 9.4–9.6

R.A. 19h 42m 48s			Decl. +10° 12′	
1405	A	15.487	190.0	1.91
1406	A	15.487	190.2	2.15
1623	A	15.687	191.4	2.12
		15.554	190.5	2.06

Oʟ 75 9.5–9.5

R.A. 19h 43m 11s			Decl. +18° 27′	
7068	F	19.389	10.2	4.35
7069	F	19.389	10.4	4.31
7116	F	19.408	9.2	4.27
		19.395	9.9	4.31

J 497 {3049} 9.5–11.5
B.D. +0°.4339

R.A. 19h 48m 48s			Decl. +0° 40′	
1434*	A	15.511	130.4	3.36
1435*	A	15.511	130.7	3.58
1743*	M	15.728	131.3	3.50
		15.583	130.8	3.48

S.A.M. 8 10–12

R.A. 19h 49m 43s			Decl. +8° 19′	
1721	M	15.717	341.6	2.92
1722	M	15.717	344.2	2.71
4017	Ol	17.398	349.5	2.84
		16.277	345.1	2.82

S.A.M. 9 10–11.5

R.A. 19h 51m 43s			Decl. +8° 13′	
1721	M	15.717	22.6	4.58
1722	M	15.717	27.1	4.52
4017	Ol	17.398	24.1	4.44
		16.277	24.6	4.51

Σ 2618 [9852] 8.6–8.9

R.A. 19h 59m 46s			Decl. +15° 14′	
3107	Ol	16.741	115.6	5.65
4422	Ol	17.699	114.8	5.58
4423	Ol	17.699	115.0	5.66
		17.380	115.1	5.63

H 907 [9986] 9.5–10.5

R.A. 20h 8m 29s			Decl. +20° 45′	
4639	M	17.824	131.9	6.08
4640	M	17.824	132.8	6.09
5845	F	18.838	131.7	6.02
		18.162	132.1	6.06

Ol 76 9.8–10.8

R.A. 20h 9m 32s			Decl. +20° 58′	
4639	M	17.824	132.9	1.32
4640	M	17.824	127.4	1.51
5845	F	18.838	137.2	1.22
		18.162	132.5	1.35

Σ 2671 [10135] 6.0–7.4

R.A. 20h 16m 26s			Decl. +55° 8′	
3256	M	16.815	337.5	3.27
3298	Ol	16.826	337.2	3.25
4577	M	17.789	338.5	3.39
		17.143	337.8	3.30

Ol 77 11–11.2

R.A. 20h 21m 7s			Decl. +54° 49′	
3298	Ol	16.826	40.7	3.79

ρ Capricorni [10228] 5.0–10

R.A. 20h 24m 18s			Decl. −18° 5′	
5217	A	18.230	171.4	2.38
5508	A	18.501	168.0	2.20
5509	A	18.501	164.8	2.09
5818	M	18.791	172.3	2.33
7096	D	19.400	169.9	2.10
7097	D	19.400	165.4	1.87
		18.604	168.6	2.16

Ol 78 10–11.0

R.A. 20h 26m 1s			Decl. +29° 52′	
7528	D	19.641	136.0	1.31
7529	D	19.641	133.5*	1.45
		19.641	135.2	1.36

E 505 {3300} 9.6–10.2

R.A. 20h 27m 20s			Decl. +30° 13′	
7528	D	19.641	14.6	2.13
7529	D	19.641	16.0	2.04
		16.641	15.3	2.08

Σ 2625 [**10504**] 7.3–8.0
R.A. 20h.41m 8s. Decl. +15° 37′

73	M	14.452	4.0	5.25
74	M	14.452	3.0	5.34
461	M	14.836	3.0	5.51
467	M	14.839	3.3	5.42
4106*	A	17.474	4.6	5.42
4107	A	17.474	4.2	5.47
		15.416	3.6	5.40

Angle and distance increasing.

γ DELPHINI [**10509**] 4.5–5.5
R.A. 20h 42m 57s Decl. +15° 50′

73	M	14.455	270.3	10.87
74	M	14.455	270.3	10.89
461	M	14.836	270.0	10.75
4094	M	17.464	270.2	10.69
4095	M	17.464	269.8	10.73
4106	A	17.474	269.6	10.78
4107	A	17.474	270.3	10.82
		16.232	270.1	10.79

Angle and distance decreasing.

E 368 {**3391**} 9.5–9.6
R.A. 20h 44m 42s Decl. +30° 38′

3134	L	16.763	356.7	3.10
3191	L	16.787	360.5	3.02
3192	L	16.787	361.1	2.98
3251	M	16.812	359.3	2.98
		16.787	359.4	3.02

ε EQUULEI [**10643**] (5.7+6.2)–7.1
R.A. 20h 55m 5s Decl. +4° 0′

435	G	14.830	73.2	10.74
548	M	14.862	72.9	10.94
580	M	14.876	72.0	10.82
1370	G	15.459	72.2	10.87
1371	G	15.459	72.3	10.74
		15.097	72.5	10.82

Change very uncertain.

ALDEN 5 9.2–10.6
R.A. 21h 8m 8s Decl. +30° 13′

1436	A	15.511	60.2	3.82
1493	A	15.547	62.9	3.55
1511	A	15.561	63.8	3.62
		15.540	62.3	3.66

J 577 {**3484**} 9–11
R.A. 21h 9m 13s Decl. +17° 42′

5921	M	18.860	19.1	2.51
7133	Ol	19.411	20.0	2.51
7134	Ol	19.411	20.0	2.60
7190	Ol	19.435	23.2	2.59
		19.279	20.6	2.55

β 271 [**10881**] 7.2–9.7
R.A. 21h 15m 10s Decl. −26° 41′

7251	Ol	19.496	246.6	3.49
7252	Ol	19.496	241.6	3.52
7253	Ol	19.496	244.6	3.51
		19.496	243.3	3.51

Binary.

OL 79 9.5–10
R.A. 21h 26m 20s Decl. −22° 24′

3402	M	16.884	340±	2.5±

ALDEN 6 9–5–11.5
R.A. 22h 10m 20s Decl. +56° 31′

5582	A	18.586	249.5	2.13
5583*	A	18.586	254.0	2.04
5597	A	18.594	252.5	1.95
5598	A	18.594	249.8	2.26
		18.591	251.1	2.11

53 Aquarii [11715] 6–6.5
R.A. 22h 22m 23s Decl. −17° 12′

1919	A	15.829	310.7	6.32
1991	A	15.856	310.6	6.28
1992	M	15.856	311.0	6.23
3193	L	16.787	311.0	6.28
3194	L	16.787	311.8	6.15
		16.223	311.0	6.25

Angle and distance decreasing.

ζ Aquarii [11743] 4.4–4.6
R.A. 22h 24m 42s Decl. −0° 24′

3255	L	16.810	308.6	2.74
3354	L	16.851	307.1	2.88
3355	L	16.851	306.6	2.98
4703	A	17.845	305.4	2.80
4704	A	17.845	306.3	2.88
		17.240	306.8	2.86

Kr 60 [11761] 9.3–10.8
R.A. 22h 25m 13s Decl. +57° 15′

3244	M	16.809	61.4	2.44
3418	M	16.891	59.2	2.35
3419	M	16.891	60.2	2.41
3438	M	16.905	61.1	2.32
		16.874	60.5	2.38
4166	M	17.507	57.6	2.31
4167*	M	17.507	57.4	2.41
4168	M	17.507	57.0	2.42
		17.507	57.3	2.37
4696	M	17.844	55.2	2.20
4697*	M	17.844	54.2	2.17
4701	M	17.847	53.2	2.20
4702	M	17.847	53.4	2.16
4727	M	17.852	54.2	2.22
4728	M	17.852	54.4	2.32
		17.848	54.1	2.22
5511	A	18.501	49.4	1.87
5512	A	18.501	49.2	2.02
5513*	A	18.501	49.4	2.08
5569	A	18.550	49.0	2.14
		18.513	49.3	2.02
5870	M	18.841	46.2	2.19
5871	M	18.841	46.4	2.18
5903	M	18.852	45.1	2.30
5904	H	18.852	46.6	2.20
5970	M	18.871	46.2	2.08
5971	M	18.871	46.4	2.23
		18.855	45.2	2.20
7850	M	19.744	36.2	1.84
7851	M	19.744	37.9	1.86
7852	M	19.744	39.6	1.91
7946	M	19.799	34.4	1.99
7947	M	19.799	34.6	1.90
		19.766	36.7	1.90

Σ 2995 [12265] 7.7–8.0
R.A. 23h 12m 26s Decl. −2° 1′

3479	L	16.930	30.4	5.00
3528	M	16.962	28.8	5.04
		16.946	29.6	5.02

Fixed.

Alden 7 10–10.9
R.A. 23h 47m 14s Decl. +50° 56′

2225	Ol	15.980	201.5	4.17
4205	A	17.578	203.0	4.19
		16.779	202.2	4.18

ALDEN (*r*) 9.2–10.2

R.A. $23^h\ 48^m\ 28^s$			Decl. +51° 07′	
2225	Ol	15.980	255.7	8.53
2227	M	15.986	255.8	8.58
		16.983	255.8	8.56

ALDEN 8 B.D. +5°.5244 9–11

R.A. $23^h\ 55^m\ 41^s$			Decl. +6° 14′	
1571	A	15.643	28.2	2.96
1572*	A	15.643	26.5	3.11
1597*	A	15.667	27.9	3.02
1598*	A	15.667	25.9	2.99
		15.653	27.3	3.01

ALDEN (*r*) 9.6–10.4

R.A. $23^h\ 52^m\ 09^s$			Decl. +51° 11′	
2225	Ol	15.980	238.6	11.36
2227	M	15.986	239.2	11.14
4205	A	17.578	238.5	11.29
		16.515	238.8	11.26

OL 80 B.D. +33°.4824 9–11

R.A. $23^h\ 59^m\ 23^s$			Decl. +34° 8′	
8165	Ol	19.917	252.1	2.66
8166	Ol	19.917	257.2	2.52
8167	Ol	19.917	257.4	2.61
		19.917	255.6	2.60

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